

U.S. EVAL Plant Fire Incident Investigation Results

Kuraray Co., Ltd. announces the results of its investigation into the fire incident (hereinafter referred to as the “Incident”) that occurred at the EVAL¹ plant of a U.S. subsidiary (Kuraray America, Inc.; hereinafter referred to as “Kuraray America”) on May 19, 2018 as follows.

1. Purposes of the investigation

This internal investigation (hereinafter referred to as the “Investigation”) was conducted to identify the root causes of the Incident after straightening out the facts, compile measures to prevent recurrences, and share these within the Kuraray Group (hereinafter referred to as the “Group”) while at the same time holding ourselves accountable to our stakeholders.

The relevant U.S. authorities² had already completed their investigation, and those authorities have released their results and determinations. Settlements have also been reached with all of the plaintiffs on the civil lawsuit (hereinafter referred to as the “Lawsuit”) that had been brought against Kuraray America related to this Incident. However, we deemed it necessary to investigate in greater depth from our own perspective. The subjects of our Investigation include responses to technology and safety management-related matters pointed out by the U.S. authorities to Kuraray America, in addition to internal control and governance frameworks at Kuraray America and addressing litigation risks that are particular to the U.S.

Many contract personnel were afflicted by this Incident. It took around five years to settle the Lawsuit, with a total settlement of approximately JPY 80 billion. We consider it vital to never let the memory of this Incident fade and to steadily implement preventive measures based on this Investigation in order to keep any similar incident from ever occurring again. We will also aim to further strengthen safety and risk management systems throughout the Group by sharing the results of this Investigation with group companies.

2. Investigation committee and method of investigation

In May 2023, we established the Incident Investigation Committee (hereinafter referred to as the “Committee”) comprised primarily of outside officers (independent officers) with the following five members in order to investigate this Incident objectively.

Chair	Outside Director	Satoshi Tanaka
Member	Outside Director	Jun Hamano
Member	Full-time Member of Audit & Supervisory Board	Kazuhiro Nakayama
Member	Outside Member of Audit & Supervisory Board	Tomomi Yatsu
Member	Outside Member of Audit & Supervisory Board	Kenji Komatsu

¹ EVAL is a registered trademark of Kuraray for an ethylene vinyl alcohol copolymer.

² OSHA (Occupational Safety and Health Administration) and CSB (U.S. Chemical Safety and Hazard Investigation Board)

In addition, an investigation team (hereinafter referred to as the “Investigation Team”) was established under the Committee to collect and verify data used in the Investigation. The Investigation Team is comprised of in-house members who are well-versed in the company’s affairs and have expertise in their respective fields.

Investigative work by the Investigation Team was performed from the perspectives of technology, governance, and dealing with litigation. The progress and results were reported to the Committee, which then discussed the content of the report from an objective standpoint upon receiving it.

The Committee’s report based on these discussions (the events of this Incident, investigation results, recurrence prevention measures and their implementation status, and future efforts to further strengthen safety and risk management systems throughout the Group) is shown below.

3. Events of the Incident, investigation results, and recurrence prevention measures and their implementation status

3-1. Events of the Incident

At 10:28 am on Saturday, May 19, 2018, a fire occurred in the polymerization process³ area of the second production line (hereinafter referred to as the “1200 Line”) of the Kuraray America’s EVAL Plant, injuring 23 contract personnel. At the time of the Incident, there was a combined total of 266 employees and contract personnel inside the plant. As ethylene was being used to raise pressure in the polymerization reactor in preparation to start up the 1200 Line after shutdown maintenance, the ethylene cooled and condensed due to erroneous manual operations, causing an abnormal temperature drop in the reactor. The reactor was then heated in response, which caused the ethylene to vaporize as pressure began to increase in the reactor. Since proper actions were not be taken to lower the abnormally high pressure within the reactor, its safety valve activated⁴ and discharged ethylene into the outside air. This ethylene then ignited, and contract personnel who had been working in the vicinity suffered burns and other injuries from the resulting fire.

3-2. Technology-related investigation results and recurrence prevention measures

a) Investigation method

Based on evidence gathered in discussions with employees who were involved in the Incident, and the results of analyzing the evidence, we focused on the following three factors in b) below as the main causes that led to the Incident. We performed various analyses on these to pinpoint the issues underlying them.

b) Investigation results and recurrence prevention measures

- 1) Abnormal rise in pressure in the polymerization reactor due to erroneous manual operation
 - Erroneous manual operations led to an abnormal rise in pressure in the polymerization reactor, and the proper actions were also not subsequently taken in response. Since this Incident occurred, we have finished switching to safety apparatus designed not to rely on human actions, establishing standards for operational tasks, and taking measures to address unclear work instructions and to compensate for insufficient understanding among operators (visualizing condition inside the polymerization reactor on a control computer, etc.). To keep safety management systems from

³ Refer to Addendum 1 (Plant Layout)

⁴ Refer to Addendum 2 (Polymerization Reactor Flow Chart)

losing their substance, we also bolstered involvement of Corporate HSE (Health, Safety, Environment)—the organization managing occupational safety at Kuraray America—in safety activities at the company’s plants and are engaged in activities to improve communication with each plant.

- 2) Insufficient risk assessment for the positioning of the discharge port in the safety valve
 - Risks in the direction that the safety valve discharges into the outside air had not been identified, and there had not been enough assessment of ignition risks after safety valve activation, nor had enough relevant measures been taken. After the Incident, we changed the position of the discharge port to a safer one that is unlikely to cause human harm.
- 3) Lax enforcement of restrictions on work-related permissions including for fire-using operations and access by unrelated personnel during high-risk startup operations
 - Schedule management (planning, coordination, notification) and risk management between departments for regular maintenance were insufficient. As a result, large numbers of contract personnel continued performing work such as construction and repairs that had been planned as regular maintenance. Insufficient skill sets of the plant manager and other managers were considered to be one reason for this, so after the Incident, we have been working to strengthen the organization by putting personnel with seasoned knowledge of production technology into the roles of president and business heads at Kuraray America.
 - Restrictions on access by personnel other than those related to startup operations, and standards for evacuation warnings when problems occur at the plant had not been documented clearly. In response, we began establishing additional rules and enacting them after the Incident.

3-3. Governance-related investigation results and recurrence prevention measures

a) Investigation results

At plants in Japan, systems had already been in place for supervision and support from those outside of production departments, including from head office and managers of each business site. However, at the time of the Incident, the Kuraray America’s EVAL Plant was operating under an autonomous security and disaster prevention system in which nearly all operations-related decisions are directed by the plant manager. Therefore, there was a strong element of decisions being made by the plant manager on a personal level, resulting in a governance system that was easily influenced by the demands of the local business.

b) Recurrence prevention measures

Based on this reflection, we have been working to strengthen their safety governance system since the Incident. Kuraray America was launched in 2008 through the integration of a trading company (in New York), and an EVAL manufacturing and sales company and SEPTON⁵ manufacturing and sales company (both in Houston, Texas). Corporate HSE was established, and its staff was increased in the context setting up the back-office functions in conjunction with this integration, but its activities were mainly focused on Responsible Care certification and regulatory compliance. Since this Incident, we have also assigned dedicated persons in charge of safety management for production processes (Process Safety Management, hereinafter referred to as “PSM”) to Corporate HSE for PSM and occupational safety in production processes

⁵ SEPTON is a registered trademark of Kuraray for hydrogenated styrenic thermoplastic elastomers.

at all Kuraray America plants, and we are working to establish common guidelines and arrange standards that should be met for all Kuraray America plants. Additionally, we are working to strengthen the following points for the safety governance system of Kuraray America as a whole.

- 1) Bolster the corporate support structure by reassigning technical personnel and assigning more of them
- 2) Improve employee safety awareness and risk prediction capabilities
- 3) Produce thorough documentation of safety systems
- 4) Clarify the hiring requirements for plant executives: Fields of experience, years of experience, qualifications, external courses taken, etc.

3-4. Investigation results and recurrence prevention measures related to dealing with litigation

a) Investigation results

There were 34 lawsuits from 164 plaintiffs brought against Kuraray America concerning this Incident. Considering these lawsuits were all related to the same case, we sought to make the court proceedings more efficient and quicker through a court procedure before the trial by a jury, but some of the lawsuits took around five years to settle, and the amount needed to pay off the settlements was approximately JPY 80 billion (of which approximately JPY 10 billion was covered by insurance). Not only did the discovery, depositions, and evaluations and analyses of documentary evidence pertaining to these 164 plaintiffs require vast amounts of time and resources, but plaintiffs also had little incentive to reach a quick settlement for reasons including:

- Not being able to individually verify the details of the harm suffered by the plaintiffs when the Incident occurred
- Verdicts in Texas injury cases were climbing into high dollar amounts
- Court procedures were suspended due to the COVID-19 pandemic, etc.

These factors complicated the handling of litigation for the Lawsuit and extended the duration of time needed to reach settlements, while also leading to more expensive settlements.

b) Recurrence prevention measures

Reasons for the extended duration of time in dealing with the Lawsuit and more expensive settlements include many unavoidable external factors. However, considering what was described in a) above, we are taking the following measures to mitigate the risk of future litigation and damages from the perspectives of insurance strategy, comprehending the damage when an incident occurs, and dealing with litigation risk particular to the U.S.

- 1) Increase the maximum limit of the comprehensive general liability insurance commonly applicable throughout the Group and have Kuraray America introduce an owner-controlled insurance program (OCIP⁶)
- 2) Install additional surveillance cameras around the perimeter of plants and at entrances at Kuraray America, introduce a strict access control system, and implement processes to get testimony from related personnel at the sites
- 3) Education about litigation risks particular to the U.S. (particularly information management and communication designed on the assumption of the discovery process)

⁶ OCIP (Owner Controlled Insurance Program): An insurance program in which an “owner” is insured in place of a contract business operator for liability of contract business operator and workers’ compensation for industrial accidents.

4. Further strengthening the safety management and risk management systems of the Group overall

In addition to recurrence prevention measures already implemented at Kuraray America, through the following measures we are also striving to further strengthen the safety management and risk management systems of the Group overall based on the results of this Investigation.

4-1. Technology-related initiatives

From the standpoint of “three M’s” (man-related measures, machine-related measures, and management-related measures), we are considering horizontally rolling out the following measures throughout the Group.

1) Man-related measures

- Education and training to improve capabilities at determining causes and identifying risks
- Bolster our safety management system through the involvement of occupational safety management organizations that are independent from the production departments of overseas plants

2) Machine-related measures

- Checking and adjusting the position and direction of the discharge ports in safety valves at other plants
- Establish plant access management and standards for evacuation warnings when problems occur
- Automate and improve the reliability of highly important emergency operations and safety apparatus

3) Management-related measures

- Make organizational and HR-related improvements for proper operation at overseas plants
- Improve employee engagement
- Introduce KPIs to track safety circumstances
- Review appropriate number of employees at overseas plants

4-2. Governance-related initiatives

We are currently building a safety auditing program directed by our Environment and Industrial Safety Management Center to monitor the state of overall safety governance from an objective perspective. Through this Investigation, we learned that listening to comments directly from worksites is important to improving employee commitment and engagement. For that reason, we are considering further strengthening our auditing program by involving Group employees with extensive experience and advanced communication skills to its ranks. We will also horizontally roll out what we learned through our investigations to improve the safety governance of the Group overall, while also utilizing these lessons in building the safety system for a new EVAL plant currently under consideration.

4-3. Initiatives for dealing with litigation

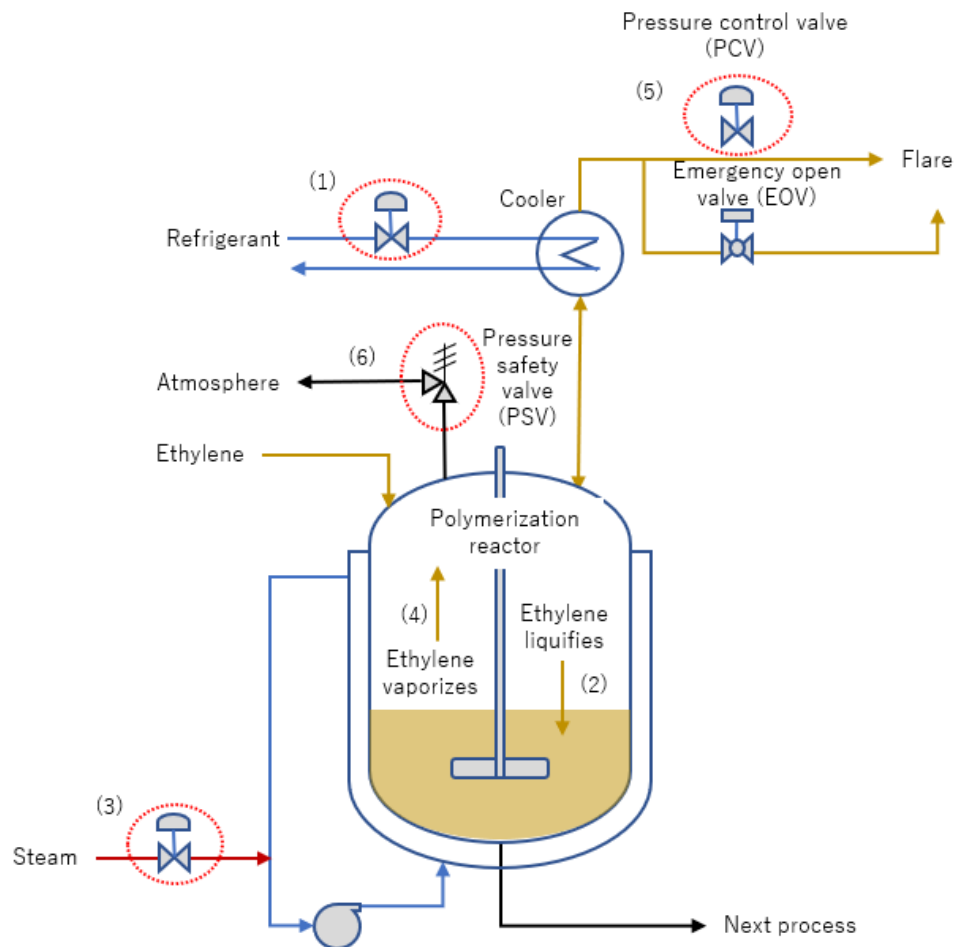
Going forward, we will consider the horizontal rollouts of initiatives mentioned in 3-4 b), while also building systems to respond to emergencies swiftly and accurately by enlisting the proper law firms, particularly where plants of our U.S. companies are located.

Addendum 1 (Plant Layout): Location where the Incident occurred is indicated by the red circle



Imagery ©2023 Airbus, CNES / Airbus, Houston-Galveston Area Council, Maxar Technologies, Texas General Land Office, U.S. Geological Survey, Map data ©2023 Google

Addendum 2: (Polymerization Reactor Flow Chart)



- (1) As pressure rose in the polymerization reactor due to ethylene, refrigerant was made to flow through the cooler which is an accessory to the reactor. As a result, the ethylene condensed and was subsequently supplied to the reactor.
- (2) The temperature inside the reactor decreased when the condensed ethylene was supplied to it.
- (3) Operators began to heat the polymerization reactor jacket (supplying steam) as a reaction to the decrease in temperature.
- (4) Heating of the polymerization reactor jacket caused the ethylene liquid to vaporize, and pressure in the reactor began to rise.
- (5) Operators released the pressure control valve (PCV) in an attempt to reduce pressure in the reactor (ethylene released through the PCV was released into exhaust gas combustion apparatus), but they hesitated to release the PCV even more to lower the pressure because they had been warned by an operation guide to limit the amount of ethylene released through the PCV.
- (6) Before activating the emergency open valve (EOV) to reduce pressure in the reactor, pressure within the reactor reached the setting value for the pressure safety valve (PSV) causing it to activate. Ethylene was then discharged into the outside air from the PSV discharge port.