INTERNATIONAL CYANIDE MANAGEMENT INSTITUTE

Cyanide Production Summary Audit Report

For the International Cyanide Management Code

Tongsuh Petrochemical Corp., Ltd.

04 April 2023

Production Summary Audit Report

Operation General Information

Name of Production Facility :	**Tongsuh Petrochemical Corp., Ltd.**
Name of Facility Owner :	**Tongsuh Petrochemical Corp., Ltd.**
Name of Facility Operator :	**Tongsuh Petrochemical Corp., Ltd.**
Name of Responsible Manager :	**Mr. Young-Ho Kim, Manager / System Management Team Tongsuh Petrochemical Corp., Ltd.**
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Operation Location Detail and Description

Tongsuh Petrochemical Corp., Ltd. (hereinafter called "TSPC") has plants at Petrochemical Complex in Ulsan City located in southern part of Korea. The sodium cyanide plant of TSPC was established in August 1985 and expanded during 1988, 1993, 2003 and 2013 respectively. Since 2013, the production capacity of solid sodium cyanide is about 70,000 ton per annum. The briquette type solid sodium cyanide is produced from sodium hydroxide and hydrogen cyanide. The hydrogen cyanide is produced as by-product from acrylonitrile plant operated within the same plant area. The solid sodium cyanide is packaged into a box or drum and exported to gold mines located abroad.

TSPC was initially ICMC certified in March 2008 and after three times re-certifications, recertified in March 2020. Since the last recertification during March 2020, there has been no significant change in production process and storage warehouse area. Three years have elapsed since the last ICMC recertification. Therefore, the recertification audit was necessary and conducted during January and February 2023. Corrective actions for a few opportunity-for-improvement issues were implemented by TSPC accordingly. There was no accident and incident related to environment, health, and safety in TSPC's operations of sodium cyanide production, packaging and dispatch since the last recertification audit.

Auditor's Finding

This operation is

X in full compliance
☐ in substantial compliance
☐ not in compliance

with the International Cyanide Management Code.

Compliance Statement

This operation has not experienced any compliance issues or significant cyanide incidents during the previous three-year audit cycle.

Auditor Information

Audit Company : QMS Consulting Co., Ltd.
Lead Auditor : Mr. BongWon Kim
Lead Auditor E-mail : kbw1999@naver.com
Dates of Audit : 26 January, 02 and 03 February 2023

Auditor Attestation

I attest that I meet the criteria for knowledge, experience, and conflict of interest for a Cyanide Code Certification Audit Lead Auditor, established by the International Cyanide Management Institute and that all members of the audit team meet the applicable criteria established by the International Cyanide Management Institute for Code Certification Auditors.
I attest that this Summary Audit Report accurately describes the findings of the certification audit. I further attest that the certification audit was conducted in a professional manner in accordance with the International Cyanide Management Code Cyanide Production Verification Protocol and using standard and accepted practices for health, safety, and environmental audits.

Tongsuh Petrochemical Corp., Ltd		04 April 2023
Name of Facility	Lead Auditor Signature	Date

Principles and Standards of Practice

Principle 1 | OPERATIONS

Design, construct and operate cyanide production facilities to prevent release of cyanide.

Standard of Practice 1.1

Design and construct cyanide production facilities consistent with sound, accepted engineering practices and quality control/quality assurance procedures.

.....	**X in full compliance with**	
The operation is.	☐ in substantial compliance with	**Standard of Practice 1.1**
.	☐ not in compliance with	

There is no significant change during the previous three-year audit cycle. The sodium cyanide plant of TSPC was established in August 1985 and expanded during 1988, 1993, 2003 and 2013 respectively. During the construction and expansion of plant, quality control and assurance activities were implemented according to the plans submitted by construction company.

During and after the construction, TSPC's engineering team and Korea Occupational Safety & Health Agency inspected the critical facilities and piping according to drawing, specification, and legal requirements. The inspections resulted in pass and the inspection report also concluded that the sodium cyanide process continued the safe operation within established parameters and protection against cyanide exposure and release.

The material of reactor, pipeline and storage tank facilities were mainly stainless as SUS304 etc. that was compatible with hydrogen cyanide and other reagents. Automatic interlock systems were established in risky areas to prevent cyanide release during emergency. To prevent the contamination of soil and water, all cyanide process facilities were established on a concrete and secondary containment. Dikes were also appropriately installed to contain spilled cyanide from tanks, piping draining back to tanks and rainwater during storm event. To prevent overfilling in reactor and storage tanks, level gauge and alarm system were effectively maintained in distributed control system. Maintenance team have tested the tank level gauge and alarm system minimum once per annum to confirm their proper functioning. For some disorder or problem identified during the tests, the maintenance team have completed corrective action. If the level of reagent and solution is reached to the high level, alarm signal is appeared in monitor and inputs of reagent and solution are automatically shut down. Therefore, it is confirmed that all the cyanide plant facilities were constructed safely and complied with the code criteria.

The cyanide product was filled in wooden box or steel drum. And those wooden box and steel drum were maintained in warehouse to prevent exposure of moisture. The cyanide products stored in warehouse in which ventilation fans were installed and operated. The cyanide product storage warehouse is secured from public access. The public was prohibited from entering the warehouse without special permission. The cyanide product packaging area and storage warehouse were monitored by CCTV. The cyanide product storage warehouse is located outside the process areas. Only the cyanide product stored in the warehouse. Another chemicals and materials can not be stored around the cyanide product storage warehouse. The cyanide products were separated from incompatible materials.

Standard of Practice 1.2
Develop and implement plans and procedures to operate cyanide production facilities in a manner that prevents accidental releases.

	..... **X in full compliance with**	
The operation is.	☐ in substantial compliance with	**Standard of Practice 1.2**
.	☐ not in compliance with	

TSPC has established and maintained safe operation procedure in which several work instructions were referenced to control facility maintenance, employee health, personnel protective equipment (hereinafter called "PPE") control, pollution control and monitoring related to cyanide process. Emergency response procedure and cyanide handling manual were also established and maintained to control emergency such as cyanide exposure and release. TSPC has implemented the change control procedure in which the issue, review and evaluation of change were defined. The implementation of proposed process, operational changes and modifications can be conducted after the review by change control committee, sign-off by environment and safety team leader and approved by plant manager. The maintenance team has implemented preventive maintenance activities according to period and method defined in program. Process main parameters such as flow rate, temperature, pressure, and level were monitored, and monitoring equipment was appropriately calibrated according to defined schedule. Cyanide solution and cyanide contaminated water in secondary containments is prohibited from discharging without authorization. Cyanide contaminated water was treated in wastewater treatment facility. TSPC has segregated, maintained, and dispatched the cyanide waste and cyanide contaminated waste to waste contractor approved by local government office.
The cyanide products were packaged and labeled according to product packaging procedure and relevant International Maritime Dangerous Goods Code. The label warning the toxic chemical storage and MSDS were attached outside the packaging wooden box and steel drum.

Standard of Practice 1.3
Inspect cyanide production facilities to ensure their integrity and prevent accidental releases.

	..... **X in full compliance with**	
The operation is.	☐ in substantial compliance with	**Standard of Practice 1.3**
.	☐ not in compliance with	

The environment and safety team has conducted routine inspection for out-side area of cyanide process. The production team has conducted routine inspection for process including tanks, valves, reactor, storage areas, secondary containments, and waste storage tank areas. Inspection frequency was determined from such criteria as importance and failure history etc. as defined in facility check and maintenance procedure. The inspection frequencies were sufficient to assure that cyanide facilities were functioning within design parameters. Inspection date, inspector and deficiency were recorded and maintained in computer system. Corrective actions for deficiency were implemented and results were recorded.

Principle 2 | WORKER SAFETY

Protect workers' health and safety from exposure to cyanide.

Standard of Practice 2.1

Develop and implement procedures to protect plant personnel from exposure to cyanide.

	..... **X in full compliance with**	
The operation is.	☐ in substantial compliance with	**Standard of Practice 2.1**
.	☐ not in compliance with	

According to PPE control procedure and safety operation procedure, employees of TSPC, visitors and contractors were prevented from exposure of cyanide during routine and non-routine operation and emergency. TSPC have installed and maintained hydrogen cyanide monitoring devices in processes. The hydrogen cyanide monitoring devices have alarm set points to limit 4.5 ppm on an instantaneous base. Response actions if those limits exceeded are defined in emergency response plan and cyanide handling manual

TSPC workers were required to contribute developing and evaluating to health and safety procedures. The safety & health committee was held every three month and results including inputs from workers were considered and results were recorded.

TSPC has identified the hydrogen cyanide condensation area, cyanide packaging area, site patrol, maintenance and overhaul work as possible area and activities where workers may be exposed to hydrogen cyanide gas and cyanide dust. And according to PPE control procedure, employees are required to use PPE such as mask, etc. And they have maintained administrative controls as applying buddy system for their employees and work permit system for external contractors.

TSPC has used monitoring device to detect the leakage of hydrogen cyanide. They also conducted inspection of working environment twice per year for such items as concentration of hydrogen cyanide, cyanide dust and noise etc. The inspection results of working environment were complied with legal requirements and ICMC criteria. The hydrogen cyanide monitoring devices installed in process and portable detectors were calibrated periodically by the maintenance team. During the maintenance, test and calibration for monitoring equipment, the maintenance team have used manuals provided by the manufacturers of monitoring equipment. The calibration records for hydrogen cyanide detectors have been retained at least five years as required by the test equipment control procedure and record control procedure.

Buddy systems were applied to repairing, inspection, patrol and maintenance works which should be conducted by more than two workers as one unit to response any potential emergency that may need help and support. The workers have used wireless telephone during those works to request assistance for the case of emergency cases.

TSPC has conducted medical check for employee every year. The medical check includes respiratory fit testing as vital capacity check for employees required to wear respirator under normal or emergency conditions. According to the medical check results, fitness of employee to perform their tasks were determined and follow up actions were implemented.

The employee, contractor and visitor shall wear the clothing provided by TSPC to go and work in cyanide process areas. When the employees, contractors and visitors leave the process areas, they shall exchange the clothing. Warning signs of cyanide presence and wearing of PPEs maintained to storage tank, process, packaging, and cyanide product storage areas. There were PPE cabinets in control room of production team, maintenance shop, product packaging and storage areas. And suitable PPEs such as mask, glove, shoes and goggle were maintained and provided to employees, contractors and visitors. Personnel as worker, visitor and contractor were prohibited the smoking, eating, drinking and open flames in potential cyanide contamination areas such as process and packaging area etc. The MSDS or warning signs advising above issues were maintained in control room, process, packaging and storage areas.

Standard of Practice 2.2
Develop and implement plans and procedures for rapid and effective response to cyanide exposure.

.....	**X in full compliance with**	
The operation is.	☐ in substantial compliance with	**Standard of Practice 2.2**
.	☐ not in compliance with	

Emergency response method and detail response items to cyanide exposures were defined in emergency response procedure and cyanide handling manual. First aid equipment such as low-pressure eye washing station, air shower, water showers and fire extinguisher were maintained in process and packaging areas. The air showers can be used for decontamination of powder cyanide. And water showers can be used for employee's dermal exposure of cyanide and liquid chemicals. Fire extinguishers located throughout the process facility are dry powder type. Those facilities and equipment were checked by monthly basis by environment and safety team and check results were maintained.
First aid kits such as salt solution, oxygen supplier, resuscitator and nithiodote type antidote were stored in cabinets installed in process area and office. They have maintained the nithiodote type antidote in their plant and affiliated hospitals in Ulsan city.
The environment and safety team has inspected the first aid equipment and kits by monthly basis. According to manufacturer guidance, the storage temperature of nithiodote type antidote need to be 15°C~30°C. So, the storage temperature of nithiodote type antidote also checked during monthly base inspection. They replaced on time the equipment and kits not effective anymore and maintained inspection records according to safety operation procedure.
The MSDS, emergency response procedure and cyanide handling manual in which first aid process defined were described in Korean language and stored in process, control room, packaging area and office.
The storage tanks, process tanks, containers and pipeline containing cyanide in process and storage tank areas were identified by marking and notice board etc. Cyanide flow directions were also marked on pipes. Decontamination details for employee, contractor and visitor leaving area were defined in cyanide handling manual. They have exchanged clothing and taken the air shower before leaving the process.
The environment and safety team member and key man in each team have received first aid training to rescue workers exposed to cyanide. First aid training as use of oxygen respirator to workers exposed to cyanide was completed for emergency response team member. External local hospitals maintaining antidote are informed and expected to administer the antidote to workers exposed to cyanide.
And also, mock drill was conducted periodically. So on-site personnel can provide first aid to workers exposed to cyanide. TSPC have three affiliated hospitals in Ulsan city that can receive medical assistance within 30 minutes by ambulance in case of emergency. TSPC has informed about potential need to treat patients exposed to cyanide. The local hospitals have understood the situation and nominated staff ready for emergency. Emergency response procedure for cyanide exposure cases has been tested every year. And the results and lessons from mock emergency drills were reflected to emergency response procedure, cyanide handling manual and emergency response plan.
TSPC has established and maintained incident evaluation procedure in which detail investigation and evaluation for cyanide exposure incident were defined. After the investigation, they shall evaluate the root cause and reflect to relevant procedure and facilities as needed. However, since last ICMC recertification, there has been no actual cyanide exposure incident.

Principle 3 | MONITORING

Ensure that process controls are protective of the environment.

Standard of Practice 3.1

Conduct environmental monitoring to confirm that planned or unplanned releases of cyanide do not result in adverse impacts.

.....	**X in full compliance with**	
The operation is.	☐ in substantial compliance with	**Standard of Practice 3.1**
.	☐ not in compliance with	

There are two discharges to surface water as rainwater discharge and in-house treated wastewater discharge. TSPC has analyzed monthly base the cyanide concentration at the outlet two discharges.
The wastewater was initially treated in wastewater treatment facility of TSPC and then sent to sewage water treatment facility operated by Petrochemical Complex Control Agency, finally treated, and discharged to sea. The cyanide concentration of discharged water shall be monitored by TSPC. Recently the monitoring results of discharged water show the cyanide concentrations are not detected to 0.06mg/l WAD complying with legal requirements and ICMC criteria. The Petrochemical Complex Control Agency have monitored the final discharged water from sewage water treatment facility monthly base. The monitoring result of free cyanide concentration during 2022 is non-detected. Therefore, cyanide concentration in the sea mixing zone was much lower than 0.022 mg/l complying with Korean legal requirements and ICMC criteria. TSPC does not indirect discharge to surface water as all cyanide process was covered by dikes, spilled cyanide, chemical and rainwater were collected and dispatched to wastewater treatment facility.
There is no regulation related to the quality of underground water. TSPC has not used the underground water in any case, so specific regulation has not been applied until now. TSPC has maintained soil environment control instruction in which detail remedial method and prevention process were defined. The cyanide seepage case requiring remedial activity was not occurred since plant operation. Therefore, it is confirmed there was no need for actual remedial activity.
TSPC has limited the hydrogen cyanide gas emissions to protect the health of employee and local community. The established limit is 4 ppm according to Korea national legal act. The monitoring results collected over the entire three-year ICMC audit period are 0.01 ppm to 0.03 ppm complying with legal requirement. Monitoring frequencies for air emission of hydrogen cyanide and water discharge were defined in atmosphere and water environment control instruction considering the Korea environment legal requirements and adequate to characterize the medium being monitored and to identify changes in a timely manner.

Principle 4 | TRAINING

Train workers and emergency response personnel to manage cyanide in a safe and environmentally protective manner.

Standard of Practice 4.1

Train employees to operate the plant in a manner that minimizes the potential for cyanide exposures and releases.

The operation is	**X in full compliance with** ☐ in substantial compliance with ☐ not in compliance with	**Standard of Practice 4.1**

TSPC has trained employees 2 hours every month for cyanide hazard issues. According to the training procedure, new employees have received 16 hours special training related to cyanide hazards.
And also, they have trained employees for the PPE usage such as what PPE should they wear, where should they wear and when should they wear.
The cyanide hazard items were reflected to annual training plan. Emergency response plan, responsibility and authority for the cyanide release and exposure were trained to existing and new employees. New employee shall receive 16 hours training related to cyanide hazard, cyanide handling and emergency response plan for leakage and exposure.
TSPC have developed and implemented training procedure in which the refresher training for employee on normal production tasks was reflected. According to the training procedure, each relevant team has provided trainings including safe working method, standard operation programs, hazards of cyanide and MSDS to employees periodically. The environment and safety team have provided safety training to overall employees in plant including the cyanide issues twice per year.
Each job, responsibility, authority and detail control method for handling cyanide and leakage were reflected to training material and the related trainings were also implemented by relevant team every year. According to training procedure, qualification of trainer was defined. The plant safety controllers qualified according to the procedure have implemented training for employees in cyanide process and packaging areas. The production team leader also qualified as safety trainer has conducted daily training before the start of daily works and monthly training.
TSPC has evaluated the training effectiveness by written test twice a year. They defined the criteria of pass for written test. Team leader has also conducted daily observation to workers to evaluate whether they properly and effectively implement the safety policy and procedures.

Standard of Practice 4.2

Train employees to respond to cyanide exposures and releases.

The operation is	**X in full compliance with** ☐ in substantial compliance with ☐ not in compliance with	**Standard of Practice 4.2**

TSPC has trained workers for emergency response procedure and cyanide handling manual including cyanide exposure and release, response to cyanide exposed worker. Detail items in the procedure and manual as following procedure, control of exposure and release were included in the training. They have conducted drills of detail emergency response plan for cyanide release and exposure. Training records were maintained throughout and individual's employment. The attendants, trainer, training topics and evaluation results were maintained as records. Employee has demonstrated their understanding of training by written examination and sometimes by report submission.

Principle 5 | EMERGENCY RESPONSE

Protect communities and the environment through the development of emergency response strategies and capabilities.

Standard of Practice 5.1
Prepare detailed emergency response plans for potential cyanide releases.

The operation is .

X in full compliance with
☐ in substantial compliance with
☐ not in compliance with

Standard of Practice 5.1

TSPC has developed and maintained emergency response plan for the response of cyanide release and exposure. In the emergency response plan, they consider the potential failure cases as catastrophic release of hydrogen cyanide, releases of solid or liquid cyanide during packaging, storage, loading and unloading operations, releases during fires and explosion, pipe, valve and tank ruptures, power outages and equipment failures, overtopping of ponds, tanks, and waste treatment facilities.
The specific response actions as anticipation of emergency cases, evacuation and estimation of personnel and community affected were reflected to emergency response plan. The detail emergency response scenario to control the release of explosion source, containment, mitigation, and future prevention including cyanide supply line shut down, prevention of cyanide spread, collection of spilled cyanide and use of antidote and first aid kit were defined in cyanide handling manual.

Standard of Practice 5.2
Involve site personnel and stakeholders in the planning process.

The operation is .

X in full compliance with
☐ in substantial compliance with
☐ not in compliance with

Standard of Practice 5.2

The emergency response plan deals with not only those plant workers assigned to their respective duties but also those concerned with the company. In the emergency response plan, all workforce of TSPC were divided into emergency response organization as communication part, personnel rescue part, excavation leading part, response part and evacuation part. Duties and responsibilities of each part were defined in the emergency plan and trained to all workforce in the plant. TSPC has identified external entities having emergency response role as local government, Korea Occupational Safety & Health Agency, fire agency, police and hospitals and defined in emergency response plan.
TSPC has prepared and established emergency communication channels to contact nearby plants at the chemical complex and potentially affected communities. And they have communicated information of the risks related to the cyanide production, release, and exposure. TSPC has engaged in regular consultation and communication with relevant stakeholders.

Standard of Practice 5.3
Designate appropriate personnel and commit necessary equipment and resources for emergency response.

The operation is .

X in full compliance with
☐ in substantial compliance with
☐ not in compliance with

Standard of Practice 5.3

All employees have been tasked with their respective duties to be performed during an emergency. TSPC has nominated the environment and safety team leader as primary emergency response coordinator, team manager as alternative emergency response coordinator and plant manager as total controller. TSPC has maintained emergency response procedure in which training items such as personnel rescue, use of first aid kit, lead excavation, control of facility etc. were defined and trained to emergency response team reader and members. And call-out procedure and 24-hour contact information for emergency response team leader, members and relevant responders were defined in the emergency response procedure and plan. In emergency response plan, team members were divided into several parts as communication part, personnel rescue part, excavation leading part and response part etc. And duties and responsibilities were defined. The environment and safety team has also tested the call-out response and evaluated the response results. The equipment for emergency response actions is maintained in a ready state through regular check and repair. A list of such equipment is appropriately maintained. TSPC has informed the cyanide related emergency response plan, risk and hazards to outside entities included in the emergency response plan. The related external interested entities such as Ulsan fire agency and nearby companies also participated in the emergency mock drill. After the mock emergency drills, evaluation, and review of effectiveness for emergency response plans were implemented.

Standard of Practice 5.4
Develop procedures for internal and external emergency notification and reporting.

	X in full compliance with	
The operation is	☐ in substantial compliance with	**Standard of Practice 5.4**
.	☐ not in compliance with	

TSPC has prepared and maintained emergency response plan in which communication with relevant internal management, regulatory agency, and external response provider such as Ulsan fire agency, Ulsan police station, Korea Occupational Safety & Health Agency, and hospitals such as Ulsan hospital and Jungang hospital. TSPC has identified such affected communities as nearby plants, companies and Ulsan local communities and they have also informed the cyanide related risk, control of emergency and excavation. The nearby companies and plants, Ulsan local communities as the Ulsan city hall for citizen, fire agency and hospitals and media as Ulsan broadcasting station were included in communication channel of emergency response plan. During December 2022, they updated the emergency response procedure and emergency response plan including notification of ICMI of any significant cyanide incidents to comply with this requirement.

Standard of Practice 5.5
Incorporate into response plans and remediation measures monitoring elements that account for the additional hazards of using cyanide treatment chemicals.

	X in full compliance with	
The operation is	☐ in substantial compliance with	**Standard of Practice 5.5**
.	☐ not in compliance with	

TSPC has prepared and maintained emergency response plan in which remedial processes and prohibit the use of concentrated chemicals as sodium hypochlorite, ferrous sulfate, and hydrogen peroxide to released cyanide in surface water or expected to enter surface water were defined. TSPC have used portable drinking water contained in bottles supplied from drinking water manufacture. They can supply portable drinking water contained in bottles from alternate drinking water manufactures.

The detail method for remediation, neutralization, decontamination, control of contaminated material and products were clearly defined in cyanide handling manual. The emergency response plan clearly addressed the potential need for environmental monitoring to identify the extent and effects of hydrogen cyanide and sodium cyanide release and include sampling method, parameter, and possible location. TSPC has not experienced the actual emergency case until now from the start of plant operation.

Standard of Practice 5.6
Periodically evaluate response procedures and capabilities and revise them as needed.

	X in full compliance with	
The operation is	☐ in substantial compliance with	**Standard of Practice 5.6**
	☐ not in compliance with	

According to the emergency response procedure, the emergency response plan shall be tested, reviewed, and evaluated every year after mock drill to check the appropriateness.
During December 2022, mock emergency drill was implemented by environment and safety team. Relevant teams as production team and maintenance team also participated. During that time, the mock emergency drill was conducted for two potential emergency cases as cyanide release and cyanide exposure of workers. And evaluations for mock emergency drill were conducted with checklist. Result were recorded and maintained.
According to emergency response procedure, emergency response plan shall be evaluated its appropriateness after the actual emergency cases and revised as needed. Actual emergency requiring the plan has not been occurred since the start of plant operation.
After the mock emergency drill during December 2022, they evaluated their emergency response plan and procedure and confirmed appropriateness with some items update.