INTERNATIONAL CYANIDE MANAGEMENT INSTITUTE

Cyanide Production Summary Audit Report

For the International Cyanide Management Code

Tongsuh Petrochemical Corp., Ltd.

25 February 2020

Tongsuh Petrochemical Corp., Ltd.

Name of Cyanide Production Facility:	**Tongsuh Petrochemical Corp., Ltd.**
Name of Facility Owner:	**Tongsuh Petrochemical Corp., Ltd.**
Name of Facility Operator:	**Mr. Jin-Pyo Hong, Plant Manager** **Tongsuh Petrochemical Corp., Ltd.**
Name of Responsible Manager:	**Mr. Young-Ho Kim, Manager** **System Management Team** **Tongsuh Petrochemical Corp., Ltd.**
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Location detail and description of operation:
Tongsuh Petrochemical Corp., Ltd. (hereinafter called "TSPC") has plants at Petrochemical Complex in Ulsan an industrial city located in southern part of South Korea. The sodium cyanide plant of TSPC was established in August 1985 and expanded in 1988, 1993, 2003 and 2013, respectively. Since 2013, the production capacity of solid sodium cyanide has been approximately 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 by ICMI in March 2008 and after twice recertification, recertified in March 2017. About three years were elapsed since the last ICMC recertification, recertification audit was performed in November to December 2019. Also, it is verified that the corrective actions for a few opportunity-for-improvement issues were appropriately completed by TSPC during this audit. There has been 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 assessment.

Auditor's Finding

This operation is

X in full compliance
in substantial compliance *(see below) with the International Cyanide Management Code
not in compliance

with the International Cyanide Management Code.

Audit Company: 3Points Co., Ltd.
Contracted Audit Team Leader: Mr. DoSik Yoon
E-mail: dosiky@naver.com
Date(s) of Audit: 25~26 November and 16 & 30 December 2019

I attest that I meet the criteria for knowledge, experience and conflict of interest for Code Verification Audit Team Leader established by the International Cyanide Management Institute and that the audit team meet the applicable criteria established by the International Cyanide Management Institute for Code Verification Auditors.

I attest that this Summary Audit Report accurately describes the findings of the verification audit. I further attest that the verification audit was conducted in a professional manner in accordance with the International Cyanide Management Code Verification Protocol for Cyanide production Operations and using standard and accepted practices for health, safety and environmental audits.

This operation has maintained full compliance with the International Cyanide Management Code throughout the previous three audit cycle.
During this recertification audit, I confirmed that TSPC has not experienced any significant cyanide incident or compliance problem during the previous three-year audit cycle.

Tongsuh Petrochemical Corp., Ltd.	DoSik Yoon	25 February 2020
Name of Facility	Signature of Lead Auditor	Date

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SUMMARY AUDIT REPORT

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

Production Practice1.1: Design and construct cyanide production facilities consistent with sound, accepted engineering practices and quality control/quality assurance procedures.

The operation is.
- .....X in full compliance with
- in substantial compliance with Production Practice 1.1
- not in compliance with

Summarize the basis for this Finding/Deficiencies Identified:

There is no significant change during the previous three-year audit cycle. The sodium cyanide plant of TSPC was established at August 1985 and expanded in 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 all relevant records related to quality control, quality assurance and inspection was appropriately maintained. 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 digital control system. Maintenance team has 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 has completed corrective action. In the event that 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.

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

The operation is.
- ..... X in full compliance with
- in substantial compliance with Production Practice 1.2
- not in compliance with

Summarize the basis for this Finding/Deficiencies Identified:

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 was defined. The implementation of proposed process, operational changes and modifications can be conducted after the sign-off by change control committee. 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 to waste contractor approved by local government office. The cyanide products were packed in a box or drum according to packaging procedure and International Maritime Dangerous Goods Code and maintained in warehouse to prevent exposure of moisture. In the warehouse, ventilation fans were installed to prevent the build-up of hydrogen cyanide gas. Storage warehouse is secured from public access as the public is prohibited from entering the warehouse without special permission.

Production Practice 1.3: Inspect cyanide production facilities to ensure their integrity and prevent accidental releases.

The operation is. ..... X in full compliance with
in substantial compliance with Production Practice 1.3
not in compliance with

Summarize the basis for this Finding/Deficiencies Identified:
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 frequency was 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.

2. WORKER SAFETY: Protect workers' health and safety from exposure to cyanide.

Production Practice 2.1: Develop and implement procedures to protect plant personnel from exposure to cyanide.

The operation is. ..... X in full compliance with
in substantial compliance with Production Practice 2.1
not in compliance with

Summarize the basis for this Finding/Deficiencies Identified:
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 has reviewed operational change for their impact on employee health and safety. And necessary measure and pre-requisite requirement identified and implemented before the change.
Employees of TSPC have participated safety & health committee to develop and evaluate safety & health procedures. TSPC has used monitoring device calibrated by the maintenance team to detect the leakage of hydrogen cyanide.
The hydrogen cyanide detectors installed in process and portable detectors were calibrated periodically by the maintenance team and the calibration records have been retained at least five years. The maintenance team has used manuals provided by the manufacturers of monitoring equipment, and the hydrogen cyanide monitoring equipment was maintained, tested and calibrated as directed by manufacturers.
Working environment was inspected twice per year for such item as the concentration of hydrogen cyanide, dust and noise. Inspection results for the concentration of hydrogen cyanide were non-detected to 0.0288 ppm in 2019 and complied with ICMC criteria and legal requirement.
TSPC has identified the hydrogen cyanide condensation area, cyanide packaging area, site patrol, maintenance and overhaul work as possible area and activities where worker may be exposed to cyanide. According to PPE control procedure, all employees are required to use PPE.
TSPC has identified areas and activities where worker can be exposed to cyanide and maintained warning signs of cyanide presence. TSPC has established and implemented the clothing change process in entrance control procedure for employees, contractors and visitors to areas that have a potential for cyanide contamination. Employees, visitors and contractors were required to wear PPE and prohibited smoking, eating and drinking in those potential cyanide contamination areas such as process and packaging areas. TSPC has maintained buddy system for repairing, inspection, patrol and maintenance works. During those works, employees use wireless telephone to request assistant for the case of emergency. Employees received medical check every year. According to the medical check results, fitness of employee to perform their tasks were determined and follow up actions were implemented.

Production Practice 2.2: Develop and implement plans and procedures for rapid and effective response to cyanide exposure.

The operation is.	..... X in full compliance with in substantial compliance with Production Practice 2.2 not in compliance with

Summarize the basis for this Finding/Deficiencies Identified:
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 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 on a monthly basis by environment and safety team and check results were maintained.
First aid kits such as water, 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 needs to be 15˚C~30˚C. The storage temperature of nithiodote type antidote is also checked during monthly based inspection. They replaced on time the equipment and kits not effective anymore and maintained inspection records according to safety operation procedure.

To control the cyanide exposure situation, TSPC has maintained internal and external communication channel and communication equipment such as wireless phone and phone. The environment and safety team member and key man in each team have received first aid training to rescue workers exposed to cyanide. And also mock drill was conducted periodically. On-site personnel are capable of providing 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. The results and lessons from mock emergency drills were also reflected to emergency response procedure, cyanide handling manual and emergency response plan.

TSPC has maintained incident evaluation procedure in which detail investigation, root cause analysis, corrective and preventive actions were defined. TSPC has maintained in process and control room area the MSDS, first aid procedure and cyanide handling manual written in Korean. The cyanide storage tanks, containers and pipeline containing cyanide were identified by marking and notice board. And cyanide flow directions were identified by arrow mark in pipeline. Decontamination details for employees, contractors and visitors leaving cyanide process were defined in cyanide handling manual. According to the manual, they have exchanged clothing and passed the air shower before leaving the process.

3. MONITORING: Ensure that process controls are protective of the environment.

Production Practice 3.1: Conduct environmental monitoring to confirm that planned or unplanned releases of cyanide do not result in adverse impacts.

The operation is.
..... X in full compliance with
in substantial compliance with Production Practice 3.1
not in compliance with

Summarize the basis for this Finding/Deficiencies Identified:

The wastewater from cyanide process was initially treated in wastewater treatment facility of TSPC Sent to sewage water treatment facility operated by Petrochemical Complex Control Agency, finally treated and discharged to sea. Monitoring results of discharged water show the maximum cyanide concentration was 0.06 mg/l Weak and Dissociable (hereinafter called "WAD") Cyanide complied with Korean legal requirement and ICMC criteria. And cyanide concentration at the sea mixing zone was much lower than 0.022mg/l and it was in conformance with legal requirements. TSPC does not indirect discharge to surface water. Because all cyanide process was covered by dike. Spilled cyanide, chemical and rainwater were collected and dispatched to wastewater treatment facility. The capacity of secondary tank is enough to collect initial rainwater poured into cyanide process area. Rainwater outside the cyanide process was discharged to rainwater line unlikely to be happened the contamination. TSPC has inspected cyanide contamination of soil according to soil environment control instruction. The result of

inspection in 2019 was non-detected. There is no regulation related to the quality of underground water. In case of intended use for underground water is decides as for drinking, agricultural or industrial purpose, specific regulation according to the intended purpose can be applied. TSPC has not used underground water in any case, so specific regulation has not been applied until now.

TSPC has limited the hydrogen cyanide gas emissions maximum 5ppm according to Korean legal requirement to protect the health of employee and local community. Monitoring results of hydrogen cyanide concentration are non-detected to 3.4ppm complying with legal requirements. The monitoring results collected over the entire three-year ICMC audit period are non-detected to 3.4 ppm, demonstrate that the operation maintained hydrogen cyanide gas emissions below the legal requirement of 5.0 ppm.
Monitoring frequency 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. The environment and safety team have monitored at frequencies defined in the instruction. With the analysis of monitoring result, TSPC can identify and implement the process change, incident and required corrective action.

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

Production 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 Production Practice 4.1
not in compliance with

Summarize the basis for this Finding/Deficiencies Identified:

According to training procedure, TSPC has trained 2 hours every month for existing employee and 16 hours special training for new employee related to cyanide hazards. TSPC has prepared and implemented annual training plan in which such items as wearing of personnel protective equipment, emergency response plan for cyanide release and responsibility, authority and detail control method for dealing cyanide were included. The annual training plan was implemented and training records were maintained. Usually plant safety controllers qualified according to procedure have implemented training for workers in cyanide process area. And also cyanide production team leader qualified as safety trainer have conducted daily training before the start of daily works and monthly training. TSPC has evaluated the training effectiveness by written test twice a year. Team leader has also conducted daily-observation to workers to check the implementation of safety policy and procedures.

Production Practice 4.2: Train employees to respond to cyanide exposures and releases.

The operation is. ..... X in full compliance with
in substantial compliance with Production Practice 4.2
not in compliance with

Summarize the basis for this Finding/Deficiencies Identified:
TSPC has trained workers for emergency response procedure and cyanide handling manual including cyanide release and employee exposure cases. 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. The results of drills for emergency response plan were evaluated and analyzed. For some deficiency and gap, the relevant procedures were revised and trained to relevant personnel. Training records were maintained throughout the company TSPC. The attendants, trainer, training topics and evaluation results were appropriately maintained as records.

5. EMERGENCY RESPONSE: Protect communities and the environment through the development of emergency response strategies and capabilities.

Production Practice 5.1: Prepare detailed emergency response plans for potential cyanide releases.

The operation is. ..... X in full compliance with
in substantial compliance with Production Practice 5.1
not in compliance with

Summarize the basis for this Finding/Deficiencies Identified:
TSPC has developed and maintained emergency response plan for the response of cyanide release and exposure. TSPC has identified potential failure and cyanide release cases in process, storage and packaging areas and reflected to emergency response plan and cyanide handling manual. In that plan and cyanide handling manual, potential release and results from that release, job description, responsibility and authority, emergency communication, rescue, use of first aid kit, evacuation and pollution prevention action were also defined.

Production Practice 5.2: Involve site personnel and stakeholders in the planning process.

The operation is. ..... X in full compliance with
in substantial compliance with Production Practice 5.2
not in compliance with

Summarize the basis for this Finding/Deficiencies Identified:
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 prepared and established emergency communication channels to contact nearby plants at the chemical complex and potentially affected communities. Communities such as local government, Korea Occupational Safety & Health Agency, fire agency, police and hospitals are included. 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.

Production 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 Production Practice 5.3
not in compliance with

Summarize the basis for this Finding/Deficiencies Identified:
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 also 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.

Production Practice 5.4: Develop procedures for internal and external emergency notification and reporting.

The operation is. ..... X in full compliance with
in substantial compliance with Production Practice 5.4
not in compliance with

Summarize the basis for this Finding/Deficiencies Identified:
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.

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

The operation is.
..... X in full compliance with
in substantial compliance with Production Practice 5.5
not in compliance with

Summarize the basis for this Finding/Deficiencies Identified:
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 were defined. TSPC has 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.

Production Practice 5.6: Periodically evaluate response procedures and capabilities and revise them as needed.

The operation is.
..... X in full compliance with
in substantial compliance with Production Practice 5.6
not in compliance with

Summarize the basis for this Finding/Deficiencies Identified:
According to the emergency response procedure, the emergency response plan shall be tested, reviewed and evaluated every year to check the appropriateness. TSPC has periodically conducted the emergency mock drill. The emergency mock drill for the year 2019 was conducted cooperatively with cyanide transportation company in August 2019. The adequacy of emergency response plan was evaluated during the mock drill and results were recorded. According to emergency response instruction, emergency plan shall be evaluated its appropriateness after the actual emergency cases and also revised as needed. Actual emergency requiring the plan has not been occurred since the start of plant operation.