INTERNATIONAL CYANIDE MANAGEMENT INSTITUTE

Cyanide Production Summary Audit Report

For the International Cyanide Management Code

Tongsuh Petrochemical Co., Ltd

03 March 2014

Tongsuh Petrochemical Co., Ltd.

Name of Cyanide Production Facility : Tongsuh Petrochemical Co., Ltd.
Name of Facility Owner : Tongsuh Petrochemical Co., Ltd.
Name of Facility Operator : Mr. An-Pyo Hong
Name of Responsible Manager : Mr. Chang-Su Han/ General Manager, System Control Team of Tongsuh Petrochemical Co., Ltd.
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Location detail and description of operation:
The Tongsuh Petrochemical Co., Ltd. (hereinafter called as Tongsuh) has plant in Petrochemical Complex in Ulsan an industrial city located in southern part of South Korea. The sodium cyanide plant of Tongsuh was established at August 1985 and expanded in 1988, 1993, 2003 and 2013 year. Now the production capacity of solid sodium cyanide is about 70,000 ton per year. 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 same plant area. The solid sodium cyanide is packaged into box or drum and exported to gold mining located in overseas area.
The Tongsuh was initially ICMC certified during March 2008 year and re-certified during March 2011. Since the ICMC re-certification during March 2011 almost 3 years was elapsed until now, there was no accident and incident related to environment, health and safety in Tongsuh operations of sodium cyanide production, packaging and dispatch.

Tongsuh Petrochemical Co., Ltd.

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.
This operation has maintained full compliance with the International Cyanide Management Code throughout the previous three audit cycle.

Audit Company : 3Points Co., Ltd.
Audit Team Leader : Mr. Sang-Ho Ahn
E-mail:triplepoint@naver.com

Date(s) of Audit: 07, 08, 21 November and 07 December 2013

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.

Tongsuh Petrochemical Co., Ltd.	S.H Ahn	03 March 2014
Name of Facility	Lead Auditor Signature	Date

Tongsuh Petrochemical Co., Ltd.	S.H Ahn	03 March 2014
Name of Production Facility	Lead Auditor Signature	Date

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:
Tongsuh sodium cyanide plant was established at August 1985 and expanded in 1988, 1993, 2003 and 2013 year. During the construction and expansion of plant, quality control and assurance activities were implemented according to plan submitted by construction company. During and after the construction, Tongsuh engineering team and Korea Occupational Safety & Health Agency inspected according to drawing, specification and legal requirements. Inspection results were passed and all relevant records related to QA/QC & inspection was maintained. Automatic interlock systems were established in risky areas to prevent cyanide release during emergency situation. To prevent the contamination of soil and water, all cyanide process facilities were established on a concrete and secondary containment. And dike were installed enough to contain spilled cyanide from tanks, piping draining back to tanks and rain water during storm event. And dual pipeline for some specific areas were installed to prevent cyanide release. To prevent overfilling in reactor and storage vessel, level gauge and alarm system were maintained in DCS system. So if the level of reagent and solution were reach the high level, alarm signal appeared in monitor and inputs were automatically shut down. So all Tongsuh cyanide plant facilities were constructed safely and comply 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:
Tongsuh established and maintained safe operation procedure to control facility maintenance, employee health, PPE, pollution and monitoring related to cyanide process. And also emergency response instruction was established and maintained to control emergency situation such as cyanide exposure and release. Tongsuh implemented the change control procedure in which the issue, review and evaluation of change were defined. Facility maintenance team 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 calibrated according to defined schedule. Cyanide solution and cyanide contaminated water in secondary containments can't be discharged without

authorization. Cyanide contaminated water treated in waste water treatment facility. Tongsuh have controlled cyanide wastes according to waste control instruction including segregation, maintain and dispatch to waste contractor approved by local government office.
The cyanide products were packed in can or drum according to packaging instruction 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. The storage warehouse is secured from public access as public can't enter the warehouse without special acceptance.

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:
Tongsuh safety team have conducted routine inspection for out-side area of cyanide process. And production team have conducted routine inspection for process including tank, valve, reactor, storage area, secondary containment and waste tank. Inspection frequency was determined from such criteria as importance, failure history etc. as defined in preventive maintenance instruction. Inspection date, inspector and deficiency were recorded and maintained in computer system. Corrective action for deficiency was implemented and result was 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:
Tongsuh employee, visitor and contractor were prevented from exposure of cyanide during routine & non routine operation and emergency situation according to PPE control procedure and safety operation procedure. Tongsuh also have reviewed proposed process and operational change for their impact on employee health and safety. Tongsuh employee have participated safety committee to develop and evaluate health and safety procedures. Tongsuh have used monitoring device calibrated by maintenance team to detect the leakage of hydrogen cyanide.
The hydrogen cyanide detectors installed in process and portable detectors were calibrated periodically by facility maintenance team and the calibration records have been retained at least five years.
Working environment was inspected twice per year for such item as the concentration of hydrogen cyanide and dust. Inspection results were "non-detected" far below from 4.7 PPM and

comply with legal requirement. Tongsuh have identified area and activities where worker can be exposed to cyanide and maintained warning signs of cyanide presence. Tongsuh have 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. Employee, visitor and contractors were required to wear PPE and prohibited smoking, eating, drinking in those potential cyanide contamination areas such as process, packaging area etc. Tongsuh have maintained buddy system in repairing, inspection, patrol and maintenance works. During those works, employee use wireless telephone to request assistant for the case of emergency situation. Employee received health check every year. According to the health check results, fitness of employee to perform their tasks were determined and follow up action 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:

General emergency plan and detail response methods to cyanide exposures were defined in Tongsuh emergency response instruction and cyanide handling manual. First aid equipment such as low pressure eye wash station, air shower and fire extinguisher were maintained in process and packaging areas. First aid kits such as water, oxygen, resuscitator and antidote were in cabinets installed in process area and office. Safety team have inspected the first aid equipment & kits by monthly basis, replaced the equipment & kits not effective any more and maintained inspection records according to safety operation procedure. To control the cyanide exposure situation, Tongsuh have maintained internal & external communication channel and communication equipment such as wireless phone and phone. Tongsuh also have installed infirmary in plant and can use ambulance operated by Petrochemical Complex Control Agency. Tongsuh have identified 3 local hospitals in Ulsan city and informed about potential need to treat patients exposed to cyanide. The local hospitals have understood Tongsuh situation and nominated staff ready for emergency situation. Emergency plan for cyanide exposure situation were tested and results were reflected to revised plan. Tongsuh have maintained incident evaluation procedure in which detail investigation, root cause analysis, corrective & preventive actions were defined. Tongsuh have 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 pipe line containing cyanide were identified by marking, notice board etc. And cyanide flow directions were identified by arrow mark in pipe line. Decontamination details for employee, contractor and visitor leaving cyanide process were defined in cyanide handling manual. According to the manual, they shall exchange clothing and pass the air shower before leaving the process. The manual actually implemented in Tongsuh plant.

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:

Waste water from cyanide process was initially treated in waste water treatment facility of Tongsuh, sent to final sewage water treatment facility operated by Petrochemical Complex Control Agency, finally treated and discharged to sea. Monitoring results of final discharged water show the maximum cyanide concentration was 0.4 mg/l WAD comply Korean legal requirement and ICMC criteria. Korea legal requirement for the maximum cyanide concentration of final discharged water is 1 mg/l WAD. And cyanide concentration at the sea mixing zone was much lower than 0.022mg/l and it was in conformance with legal requirements. Tongsuh do not have indirect discharge to surface water. Because all cyanide process were covered by dike. Spilled cyanide, chemical and rain water were collected and dispatched to waste water treatment facility. The capacity of secondary tank is enough to collect initial rain water poured into cyanide process area. Rain water outside the cyanide process was discharged to rain water line unlikely to be happened the contamination.

Tongsuh have inspected cyanide contamination of soil according to soil environment control instruction. The result of inspection for 2013 year 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. Tongsuh have not used underground water in any case, so specific regulation has not been applied until now.

Tongsuh have limited the hydrogen cyanide gas emissions maximum 10ppm according to Korean legal requirement to protect the health of employee and local community. Monitoring result of hydrogen cyanide concentration is 0.001ppm. Monitoring frequency for air emission of hydrogen cyanide and water discharge were defined in atmosphere and water environment control instruction. With the analysis of monitoring result, Tongsuh 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, Tongsuh have trained 2 hours every month for existing

employee and 16 hours special training for new employee related to cyanide hazards. Tongsuh have prepared and implemented annual training plan in which such items as wearing of personnel protective equipment, emergency preparedness 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. Qualification of safety trainer was defined. Usually plant safety controllers qualified according to procedure have implemented training for workers in cyanide process area. And also cyanide process team leader qualified as safety trainer have conducted training before the start of daily works. Tongsuh have evaluated the training effectiveness by written test. And also team leader have conducted daily observation for 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:

Tongsuh employees are well aware of the emergency response actions against cyanide exposures and releases by repeated education and training. The emergency response plans specify all the employees' duties such as safety representative, first-aid responder or firemen, etc. Emergency mock situation drills are regularly conducted to ensure that the employees are familiar with their duties and roles. The results of the emergency mock situation drills are evaluated and analyzed. For some deficiency and gap, the relevant procedures were revised and trained to relevant personnel. The results of education and training are recorded.

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:

Tongsuh have developed and maintained emergency response plan for the response of cyanide release. In that plan, potential release and results from that release were defined. And Tongsuh have prepared and maintained the emergency response instruction and Cyanide Handling Manual in which such detail items as emergency communication, rescue, use of cyanide antidote, first aid, evacuation, relief and pollution prevention action were 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. Tongsuh have prepared and established emergency communication channels to contact nearby plants at the chemical complex and potentially affected communities. Communities such as local government and environment authorities, fire stations, police and hospitals are included. And they have communicated information of the risks related to the cyanide production, release and exposure. Tongsuh have 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. Tongsuh have nominated safety team leader as primary emergency response coordinator, safety team manager as alternative emergency response coordinator and plant manager as total supervisor. In emergency response plan, the organization was consisted of rescue part, excavation leading part and communication part etc. Detail training such as personnel rescue, lead excavation, control of facility and etc. were required and provided to emergency responders. And also safety team 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 also maintained. Moreover, a cooperative system with outside entities has been established effectively. The outside entities are participated in the mock emergency drills. 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:
Tongsuh have prepared and maintained emergency response plan in which communication with relevant internal management, regulatory agency and external response provider such as Ulsan

Tongsuh Petrochemical Co., Ltd. S.H.Ahn 03 March 2014

Name of Production Facility | Lead Auditor Signature | Date

fire agency, Ulsan police station, Korea Occupational Safety & Health Agency and hospital such as Ulsan hospital and Jungang hospital. Tongsuh have identified such affected communities as nearby plants, companies and Ulsan local communities and also they have 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:
Tongsuh have 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. 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. Tongsuh have not experienced the actual emergency case until now from 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:
Tongsuh have conducted the emergency situation mock drills periodically. The adequacy of emergency response plan was checked and evaluated during the mock drill and results were recorded. According to emergency response instruction, emergency plan shall be evaluated it's appropriateness after the actual emergency cases and also revised as needed. Actual emergency requiring the plan has not been occurred since the plant operation.

Tongsuh Petrochemical Co., Ltd.	S.H Ahn	03 March 2014
Name of Production Facility	Lead Auditor Signature	Date