INTERNATIONAL CYANIDE MANAGEMENT INSTITUTE

Cyanide Production Summary Audit Report

For the International Cyanide Management Code

TaeKwang Industrial Co., Ltd.
Petrochemical Plant #3

06 June 2017
TaeKwang Industrial Co., Ltd. Petrochemical Plant #3

Name of Cyanide Production Facility  TaeKwang Industrial Co., Ltd.
Name of Facility Owner  TaeKwang Industrial Co., Ltd.
Name of Facility Operator  Mr. Byeong-Gu Lee
Name of Responsible Manager  Mr. Jang-Soo Seo / Safety Team Leader
Address  68 Bugok-ro, Nam-gu,
          Ulsan-city, 44785
Country  South Korea
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Location detail and description of operation:

TaeKwang Industrial Co., Ltd. has plant in Petrochemical Complex in Ulsan Metropolitan City
an industrial city located in southern part of South Korea. The sodium cyanide plant of
TaeKwang Industrial Co., Ltd. was constructed during 1996 year and started production at
April 1997 year. The production capacity of solid sodium cyanide is about 63,000 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.
TaeKwang Industrial Co., Ltd. was initially ICMC certified during April 2008 year and
recertified during May 2011 year and May 2014 year. Almost 3 years were elapsed since the last
ICMC recertification, so third recertification audit is needed during this time.
The recertification audit was performed during March and April 2017. There was no accident
and incident related to environment, health and safety in TaeKwang Industrial Co., Ltd.'s
operations of sodium cyanide production, packaging and dispatch since May 2014 when they
ICMC recertified until now April 2017 year.
The plant address was changed since last recertification audit according to national address
reset strategy. However the location itself was not changed.

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Auditor’s Findings

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 year audit cycle.

Audit Company: 3Points Co., Ltd.
Audit Team Leader: Mr. Sang Ho Ahn
E-mail: triplepoint@naver.com
Dates of Recertification Audit: 30, 31 March and 07 April 2017

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 all members of 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.

During this recertification audit, I confirmed that the TaeKwang Industrial Co., Ltd. have not experienced any significant cyanide incident or compliance problem during the previous three-year audit cycle.

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

Production 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 □ in substantial compliance with □ not in compliance with Production Practice 1.1

Summarize the basis for this Finding/Deficiencies Identified:

The sodium cyanide plant of TaeKwang Industrial Co., Ltd. was constructed during 1996 and started operation at April 1997. Before the construction, facility and piping material were tested by suppliers. The construction company implemented test and inspection according to quality plan and submit the results to technical team and supervising agency. Technical team and supervising agency reviewed the result reports and concluded that facilities were established according to drawing and specification. The cyanide process has received the PSM (Process Safety Management) inspection by KOSHA (Korea Occupational Safety & Health Agency) and Ministry of Labor every four year according to Korea legal requirement. According to the inspection reports from KOSHA, TaeKwang Industrial Co., Ltd. continued operation within established parameters and protection against cyanide exposure and release. Records related to quality control and assurance inspection were maintained. And also the materials used for construction are compatible with hydrogen cyanide, liquid sodium cyanide and other reagents. Emergency shut down system and automatic interlock system were applied to control the shut down of production system and prevent release due to power outage or equipment failures.

To prevent cyanide seepage to subsurface, all cyanide process facilities including condensation, reaction, centrifuge, drier, packaging, storage and pipeline were established and controlled on concrete. Level gauge and alarm system were installed to cyanide process and storage vessels to prevent overfilling and overflow. Secondary containment and dikes were installed enough to contain spilled cyanide solution. And also pipelines were covered by outer piping to prevent spillage of cyanide solution.

Since the last recertification audit during 2014 year, there are several light facility changes including modification of pump recycle line, installation of by-pass line and flash drum. Those facility changes were completed under the change control procedure. For each case, change control committee was opened. The change control committee checked quality, environmental and safety issues and finally approved the changes. After the facility changes, technical team inspected the changed facility, revised operation manual, trained operators and maintained inspection reports and training records. The quality control and quality assurance records including test and inspection reports from engineering and construction company and review results by technical team were maintained. And also records generated from change control committee, test and inspection reports from external agency were maintained according to record control procedure.

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Production 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 Production Practice 1.2
□ not in compliance with

Summarize the basis for this Finding/Deficiencies Identified:

The production team has established and maintained process operation manual in which standard practices such as operational criteria for pressure, temperature and flow were defined. And also they have maintained start-up and shut down manual and packaging procedure. The maintenance team and safety team have maintained preventive maintenance procedure and emergency response procedure to assure safe and sound process operation.
They also have established and maintained emergency response plans to control the possible emergency situations such as spillage, hydrogen cyanide leakage, fire, explosion and human cyanide exposure. They have tested the emergency response plan periodically. They established and maintained change control procedure in which identification and control of change were defined. Maintenance team established and implemented preventive maintenance program.
Main process parameters as flow rate, temperature and level were monitored by DCS and monitoring equipment was calibrated according to calibration procedure. Cyanide solution and cyanide contaminated water has been treated in waste water treatment facility and prevented unauthorised and unregulated discharge according to waste control procedure. The solid waste were collected and dispatched to qualified sub-contractor according to waste control procedure. The cyanide products were filled and packed in steel drum and wooden box and stored in warehouse in which ventilation fans were installed and operated to prevent exposure of moisture. The cyanide products were packaged according to packaging procedure in which the IMDG(International Maritime Dangerous Goods) code reflected. The public is strictly prohibited to enter the warehouse without special acceptance. The warehouse is monitored by CCTV.

Production 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 Production Practice 1.3
□ not in compliance with

Summarize the basis for this Finding/Deficiencies Identified:

The main facilities including reactor, tank, valve and pipeline were inspected periodically according to self inspection procedure. And also detail inspections were implemented by special inspection contractors every five years. The secondary containments and deterioration and leakage were checked and results were recorded daily by production team and safety team. Inspection frequency for reactor, tank and pipeline was defined from the decision of critical item control rule according to self inspection procedure and maintenance procedure.

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The inspection frequency for reactor, tanks, and pipeline was determined and defined in self-inspection procedure, maintenance procedure, and facility significance grade control procedure. Recently there was no severe incident and accident related to equipment failure. The current frequency of preventive maintenance and inspection were properly established and sufficient to prevent failure, incident, and accident. Inspection results including inspection date, inspector, and deficiency were recorded. And also corrective actions for identified deficiency were implemented according to corrective and preventive action procedure.

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
- [ ] not in compliance with Production Practice 2.1

Summarize the basis for this Finding/Deficiencies Identified:

Since initial certification during the 2008 year, TaeKwang Industrial Co., Ltd. have established and implemented safety control procedure and PPE control procedure both were revised during 2014 year. Employee, visitor, and contractor were protected from exposure of cyanide during normal, abnormal, and emergency operation, maintenance, and overhaul activities according to safety control procedure and PPE control procedure. And also each team have developed and maintained work instructions including detail control and handling method of sodium cyanide and hydrogen cyanide for processes including raw material control, production, packing, and shipping. They have developed and maintained work permit procedure for out-sourced repair and maintenance works. Training for precaution and handling of cyanide have been implemented before repair and maintenance works and PPE wearing are mandatory for workers according to work permit procedure. They have reviewed facility and operational changes for their impacts on employee health and safety. Employee have participated safety committee to develop health and safety procedures. Working environment was inspected by external agency twice per year for such items as the concentration of hydrogen cyanide and sodium cyanide dust. The inspection results of hydrogen cyanide and sodium cyanide dust were usually comply with ICMC and Korea legal requirement. They also used monitoring device to detect the leakage of hydrogen cyanide. The fixed monitoring equipment and portable detectors for hydrogen cyanide were calibrated every year. Employee, contractor, and visitor shall wear clothing provided by safety team and exchanged clothing when they are leaving cyanide process according to safety and health control procedure. They identified areas and activities where workers can be exposed to cyanide and maintained warning signs of cyanide presence. Employee, visitor, and contractor were required to wear PPE and prohibited from smoking, eating, drinking in those potential cyanide contamination areas such as process and packaging areas. They maintained buddy system for dangerous works as patrol, maintenance, and repair works. During these works, employee and contractor use radio to request assistant for the case of emergency situation. Employee receives health check every

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year. And according to 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.

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

Summarize the basis for this Finding/Deficiencies Identified:

TaeKwang Industrial Co., Ltd. have maintained emergency response plan development
procedure. According to the procedure, they have developed and maintained detail emergency
response plans including emergency response plans for leakage of toxic gas, for spillage of
sodium cyanide and for humane exposure. 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 maintained in cabinets installed in
process area and office. Safety team have inspected the first aid equipment and kits by monthly
basis and replaced the equipment and kits not effective any more according to safety procedure.
They maintained the MSDS, first aid procedure, emergency plans and cyanide handling method
written in Korean in process and control room area. The storage tanks, containers and pipe line
containing cyanide were identified by material name, MSDS and warning signal. And cyanide
flow directions were identified by arrow mark in pipe line. They have established and
implemented basic safety procedure and visitor safety control procedure to control the entrance
and leaving from process area. According to the procedure, employee, contractor and visitor
shall exchange clothing and pass the air shower before leaving the process. They have employed
nurse and maintained first aid kits in plant. They nominated JungAng Hospital in Ulsan city
and informed about potential need to treat employee exposed to cyanide. The JungAng Hospital
understands TaeKwang Industrial Co., Ltd. situation and nominated staff ready for emergency
situation. Emergency plans of cyanide exposure cases were tested every year and the result and
lesson were reflected revised plans. They established and maintained incident evaluation
procedure in which detail investigation and evaluation for cyanide exposure incidents were
defined. Since the last recertification audit during 2014 year, cyanide exposure incident has not
been occurred in their plant.
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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.

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

Summarize the basis for this Finding/Deficiencies Identified:

Waste water from process was treated in waste water treatment facility and then discharged to Yongyeon final waste water treatment facility operated by Ulsan Metropolitan City. Monitoring results of discharged from in-house waste water treatment facility showed the cyanide concentration range was 0.10ppm to 0.40ppm during 2014 to 2017 year and comply with ICMC requirement and Korea legal requirements. The discharged water is mixed and diluted in Yongyeon final waste water treatment facility, so the cyanide concentration is far below the 0.022mg/l. TaeKwang Industrial Co., Ltd. do not need to monitor the free cyanide concentration in mixing zone, because the final waste water treatment facility has been operated by Ulsan Metropolitan City. TaeKwang Industrial Co., Ltd. do not discharge to surface water. Because all cyanide process were covered by dike and spilled cyanide, chemical and rain water were collected and dispatched to waste water treatment facility in the plant. The capacity of secondary tank is enough to collect initial water poured into cyanide process area. In Ulsan Metropolitan City, there is no designated beneficial use of ground water, no regulatory requirement of compliance and no actual beneficial use of the ground water. So they do not monitor the quality of ground water. Only they have conducted the monitoring of land contamination to preserve land and soil. The result of recent test was that the cyanide was not detected. They limited the hydrogen cyanide gas emissions maximum 5.0 ppm according to Korean legal requirement to protect the health of employee and local community. Monitoring result of hydrogen cyanide concentration was 0.1 ppm to 1.0 ppm during 2014 year to 2017 year. Monitoring frequency for air emission of hydrogen cyanide and water discharge was defined implemented according to Korea legal requirements. With the analysis of monitoring results, they can identify the process change, incident and implement 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.

........ X in full compliance with
The operation is. □ in substantial compliance with Production Practice 4.1
          □ not in compliance with

Summarize the basis for this Finding/Deficiencies Identified:

Since 2008 year, TaeKwang Industrial Co., Ltd. have established and implemented safety training procedure. Their training procedure and program were established effectively to meet the legal requirements and international standards including this ICMC code. According to the safety training procedure and plan, the safety team and production team provide 2 hours safety training to employee in sodium cyanide process, packaging area, maintenance team and utility team every month for cyanide hazard issues including MSDS, emergency response plan, PPE usage and maintained records as required by Korea Occupational Safety and Health Act.

The safety team has implemented the health and safety training for overall employees in the plant. And also each team employees need to receive training related to safety working method and standard operation procedures by each team leader or supervisors. Emergency plans and scenarios have been prepared and reviewed through mock emergency drills conducted as planned interval. The responsibility and authority in emergency situation for the case of cyanide release were trained to existing and new employees regularly.

The responsibility, authority and detail control method for each job such as production work, maintenance activities, packing, logistics, transportation and other administration activities are described in the training material and standard operation procedures. Related to the control of main processes in plant, the standard operation procedures were consisted of seven parts applicable to reactor area, crystallizer area, solid area, packaging area, waste water treatment area, unloading area and others. The standard operation procedures were used as training materials for new and existing employees.

The trainings have been provided by manager, safety team leader and members qualified according to training procedure. Training effectiveness has been evaluated every six month by testing and observation. The evaluation results are reflected on training plan. And also all new employees prior to perform their job should be trained on safety and health for 16 hours at the time of joining the plant and for regular training according to yearly training plan thereafter.
Production Practice 4.2: Train employees to respond to cyanide exposures and releases.

...... X in full compliance with
The operation is. □ in substantial compliance with Production Practice 4.2

.. □ not in compliance with

.. □ not subject to

Summarize the basis for this Finding/Deficiencies Identified:

Since 2008 year, Taekwang Industrial Co., Ltd. have prepared and implemented training plans including the emergency response plan for cyanide release and exposure, were included. According to the safety training procedure and yearly training plan, safety team and production team provided training for all employees related to the emergency response procedure for cyanide release and exposure. All employees are aware of the emergency response actions against cyanide exposures and releases through repeated training and mock emergency drills. Mock emergency drills are regularly conducted to ensure that the employees are familiar with emergency response plans, duties and roles. The results of the mock emergency drills are evaluated with checklist. The emergency response plans are updated timely and any area need for improvement found was improved. The results of training and emergency mock drills are recorded.
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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.

............ X in full compliance with
The operation is. □ in substantial compliance with □ not in compliance with

Production Practice 5.1

Summarize the basis for this Finding/Deficiencies Identified:

Since 2008 year, TaeKwang Industrial Co., Ltd. have prepared and maintained five detail emergency response plans according to emergency response procedure. Detail methods to control the release, containment, mitigation and future prevention including cyanide supply shut down, prevention of cyanide spread, collection of spilled cyanide and preventive action were defined in emergency response plans. All the necessary actions covering emergency communication, rescue, evacuation, relief, pollution prevention, assessment, communication with relevant institutions were defined in the emergency response plans. And also job description as responsibility and authority were defined in emergency response plans. The emergency response plans defined the use of cyanide antidotes and first aid kits for cyanide exposure. Production team and safety team have conducted mock emergency drills according to the emergency response plan. They reviewed the results of each mock emergency drill and updated the emergency response plan as needed.

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

............ X in full compliance with
The operation is. □ in substantial compliance with □ not in compliance with

Production Practice 5.2

Summarize the basis for this Finding/Deficiencies Identified:

Since 2008 year, TaeKwang Industrial Co., Ltd. have developed and maintained emergency response plans and emergency communication channels. The emergency response plans and communication channels considered not only employees in the their plant but also those related and concerned with the plant. They have prepared and established emergency communication channels to contact nearby plants at the Ulsan Chemical Complex and potentially affected communities. Communities such as local government office, fire agency, broadcasting station, police, Environment Management Agency and hospitals were included and they have communicated information of the risks related to the cyanide production, release and exposure. They engaged in regular consultation and communication with relevant stakeholders.

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Production Practice 5.3: Designate appropriate personnel and commit necessary equipment and resources for emergency response.

X in full compliance with
The operation is. □ in substantial compliance with □ not in compliance with Production Practice 5.3

Summarize the basis for this Finding/Deficiencies Identified:

TaeKwang Industrial Co., Ltd. have nominated safety team leader as primary emergency response coordinator, technical team leader as alternative emergency response coordinator and plant manager as total supervisor. In emergency response procedure and plans, the emergency response organization was consisted of communication team, personnel rescue team, excavation leading team and facility control team. Detail training such as personnel rescue, lead excavation and facility control were required and provided to emergency responders. And also safety team tested the call-out response and feedback the results to responders. The list of emergency response equipment was defined in emergency response plans and maintained in each relevant team. Emergency rescue equipment such as PPE including toxic gas mask, glove and antidote were maintained in each relevant team. And all emergency response equipment inspected and tested regularly by safety team to ensure availability during emergency situation. The role, responsibility and detail communication channel for outside responders and communities such as fire agency, Ulsan Chemical Complex safety managers committee, Ulsan city, nearby companies and hospitals were defined in emergency plans. And also the outside entities have participated in the mock emergency drills.

Production 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 □ not in compliance with Production Practice 5.4

Summarize the basis for this Finding/Deficiencies Identified:

TaeKwang Industrial Co., Ltd. have defined the emergency communication channel, communication method and contact information in emergency response procedure and plans. In internal communication channel, the contact information as telephone number etc. for top management, plant manager, each team leader and safety team members were identified. In external communication channel, regulatory agencies such as Ulsan Municipal Office, Korea Safety and Health Agency, labor office and outside response providers such as fire agency, nearby plants and hospitals were identified. And through emergency simulation test, they identified potentially affected communities as nearby companies and plants. The communication methods and contact information such as telephone, mobile phone etc. for relevant personnel of outside responders and potentially affected communities were identified and updated in emergency response plans.
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Production Practice 5.5: Incorporate into response plans and remediation measures monitoring elements that account for the additional hazards of using cyanide treatment chemicals.

\[ \text{X in full compliance with} \]
\[ \text{The operation is.} \quad \square \text{in substantial compliance with} \quad \square \text{not in compliance with} \quad \text{Production Practice 5.5} \]

Summarize the basis for this Finding/Deficiencies Identified:

TaeKwang Industrial Co., Ltd. have established emergency response procedure and toxic chemical neutralization plan. Detailed methodologies for remediation, neutralization, decontamination and control of contaminated material were defined in the procedure and plan. The toxic chemical neutralization plan defined that sodium hypochlorite, ferrous sulfate and hydrogen peroxide shall not be used to treat and neutralize the cyanide released into surface water. They also have established the environmental monitoring for emergency release to identify the extent and effect of release, sampling methods, parameter and possible location in emergency response procedure and plans.

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

\[ \text{X in full compliance with} \]
\[ \text{The operation is.} \quad \square \text{in substantial compliance with} \quad \square \text{not in compliance with} \quad \text{Production Practice 5.6} \]

Summarize the basis for this Finding/Deficiencies Identified:

TaeKwang Industrial Co., Ltd. have conducted emergency response mock drills every year. And the emergency response plans were reviewed and evaluated for their appropriateness and revised as needed. According to emergency response procedure, emergency response plans shall be evaluated its appropriateness after the actual emergency situation and also the plans are revised as needed. Actual emergency situation requiring the plans has not been occurred since last recertification audit and the plant operation.

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Date

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