

**Neste Rotterdam Site Development Project**

*Technical Proposal for HAZOP and LOPA Review*

**Technip Italy S.p.A**

**Neste Corporation (NESTE)**



**Neste Rotterdam Site Development Project**

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# Introduction

Neste Corporation (NESTE) is planning to increase production capacity at their Rotterdam refinery as a part of the Neste Rotterdam Site Development Project. TECHNIP ITALY S.p.A. has been awarded by NESTE for execution of services for Neste Rotterdam Site Development Project.

Technip has invited IRESC to submit a proposal for undertaking the HAZOP and LOPA Review studies for the Neste Rotterdam Site Development Project.

This proposal presents the scope of work, study approach, company experience, and proposed team for the services to be provided by IRESC.

# Scope of Work

According to Neste plan, overall project implementation strategy may be split in phases. The first phase will consist of a Project entailing two parallel (sub)projects, which have the following objectives:

* JET, to implement RJF production in existing NEXBTL
* IP, to meet requirement for waste water discharge when running at desired plant capacity using high nitrogen feedstocks.

The Definition phase of Rotterdam Site Development Project is commencing with the Definition services associated to the JET project whose Feasibility activities have been completed at end of June 2020 while Definition Phase of IP project is expected to start on early September 2020.

IRESC scope of work will include performing HAZOP and LOPA studies for the following units in both Jet Project and Infrastructure Project (IP) of Neste Rotterdam Site Development Project:

For JET:

* A new section (Unit 20) to produce RJF from RDiesel in existing NEXBTL unit;
* New Hot Oil Furnace (Unit 55 – 56);
* Two new storage tanks for RJF (Unit 40);
* New loading arms at jetty for RJF loading (Unit 46); and
* Interconnection inside plant (Unit 80);

For IP:

* Waste Water (WW) buffer tank, new WW transfer pumps and filters to WW pipeline located in Interconnecting Corridor (before pigging facilities) (Unit 60);
* New WWT (Unit 61) in Maasvlakte New Area (MNA);
* On purpose utility generation (Unit 51);
* Interconnection at new area (Unit 81); and
* Pipeline corridor between the two areas (Unit 82).

HAZOP and LOPA studies are workshop based studies and will be conducted primarily in videoconference due to uncertainties in overseas travelling under Covid-19 travel arrangement.

The following will be included in the scope of the work provided by IRESC:

* Providing facilitator and scribe (technical secretary), equipped with notebook computer and PHA-Pro 8 software for HAZOP and LOPA Review studies;
* Preparation and issuance of HAZOP and LOPA/ SIL Reports for each unit i.e., one report each for Unit 20, Hot Oil Furnace (Unit 55 – 56), Unit 40, Unit 46, Unit 80, Unit 60, Unit 61, Unit 51, Unit 81, and Unit 82;
* Preparation of Preliminary SIL Classification report for each unit i.e., one report each for Unit 20, Hot Oil Furnace (Unit 55 – 56), Unit 40, Unit 46, Unit 80, Unit 60, Unit 61, Unit 51, Unit 81, and Unit 82.

It is understood that the following will be arranged by Technip for the workshop studies:

* Worksheet templates for HAZOP and LOPA review;
* Meeting room facilities including overhead projector/s;
* Participation of relevant team members from Company/Owner, Contractor, Licensor and Vendor (where applicable);
* Documentation that will be used during session for reference; and
* Scanning of Master P&IDs and conversion to e-file.

Facilitator and scribe will attend one day training program by Neste on video conference. The training session will be organized by Neste to ensure common approach application of procedure.

The workshop study sessions will be conducted in English. All study reports will be in English.

# Proposal Basis and Assumptions

Our proposal is based on the assumptions and conditions listed below and those in Section 2 of the proposal.

* The scope of work is limited to the facilities as described in Section 2 of this proposal. Assessment for additional facilities not described in the RFQ will not be considered. An exception to this may be considered on a case-by-case basis, if such requirements are communicated to IRESC before the commencement of the studies and the additional effort involved is not significant.
* It has been considered that all studies will be commenced within a reasonable time period upon the award of the study. If the schedule for all or part of the studies or facilities are postponed significantly due to reasons beyond IRESC’s control, we reserve the rights to replace the proposed study team members with other qualified personnel depending on our staff’s availability. A variation order may be issued to capture any additional effort/ cost incurred on a justifiable basis due to the postponement.

# Study Approach

The study approach and methodology for HAZOP and LOPA studies will primarily follow Process Risk Classification (NOQD 429) and Layers of Protection Analysis for Process Hazards (NOQD 468). We have reviewed the HAZOP LOPA project specifications and find these to be in line with the approach adopted by IRESC in past projects. Our facilitators are familiar with the approach specified in these procedures.

The following sub-sections provide an overview of the general approach that will be adopted in each of the studies.

## HAZOP Study

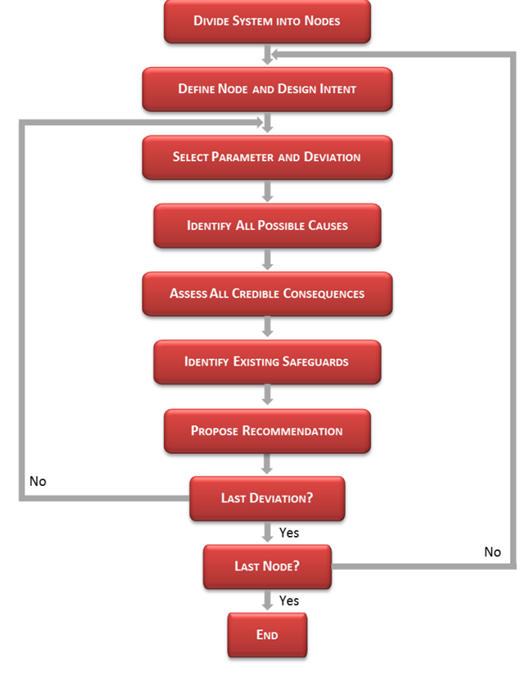
A “Hazard and Operability” – HAZOP is a structured and systematic review of a process facility by the HAZOP team utilizing the diverse range of skills from the HAZOP team members. The main objective of the HAZOP is to identify and evaluate the potential hazards and operational issues which may arise from possible deviations during plant operations.

The HAZOP will be a team exercise involving engineers/ specialists from a variety of departments/ specialties, such as process design, operations and instrumentation, guided by a HAZOP facilitator who will be experienced in leading HAZOP sessions with sound knowledge in engineering and hazard assessment.

The HAZOP study will be carried out primarily based on P&ID. According to the process functionalities, the facility subjected to the HAZOP will be divided into a number of discrete systems (i.e. Nodes) for review. The HAZOP nodes to be studied are typically defined during the session by consensus of the HAZOP team. Each selected node will then be studied consecutively by examining the potential deviation from normal operation that leads to undesired hazards using appropriate set of guidewords. A schematic of the HAZOP review process is provided in Figure 4.1. Example HAZOP guidewords are listed in Table 4.1.

**Table 4.1 Typical HAZOP guidewords**

| **System Parameters** | **Guide Word** | **Remarks** |
| --- | --- | --- |
| Flow | More |  |
| No/Less |  |
| Reverse |  |
| Pressure | High |  |
| Less | Includes vacuum |
| Temperature | High |  |
| Low |  |
| Level | High | Includes interface high level |
| Low | Includes loss of level, interface low level and loss of interface level |
| Contamination/ Composition Change | Composition |  |
| Maintenance / Testing /Utilities | Other Than |  |

**Figure 4.1 Schematic Diagram of HAZOP**

The potential causes and respective consequence for each deviation will then be assessed. Causes of the deviation may include malfunction of process control systems, blockages or any operational errors etc. leading to hazards such as fire and explosion. The existing safeguards in the design to protect the hazards will also be identified and remedial actions will be considered where required. The team members will then evaluate qualitatively or semi-quantitatively to decide whether existing design safeguards are sufficient, or whether additional actions are necessary to reduce risk to an acceptable level. Where potential design inadequacy/ area for further improvement are identified, this will be recorded as HAZOP recommendation for further actions.

Based on Project specification Process Risk Classification (NOQD 429), risk ranking will be performed based on likelihood and severity of the consequence. The project risk matrix will be used to perform the risk ranking.

The proceedings will be recorded in HAZOP worksheet using PHA Pro 8 software. The HAZOP worksheet template provided by NESTE will be used for the study. A HAZOP study report for each unit will be issued after the completion of the workshop which will include details of the study team, study worksheets, findings and recommendations.

## layer of protection analysis (lopa) study

IEC 61508: 2010/ 61511:2016 sets out a generic approach for all safety lifecycle activities for electrical/ electronic/ programmable electronic systems (E/ E/ PESs) that are used to perform safety functions. The LOPA study will be performed in accordance with Project specification, Layers of Protection Analysis for Process Hazards (NOQD 468, 6 April 2018).

The Safety Integrity Level (SIL) is a set of discrete level for specifying the safety integrity requirements of the Safety Instrumented Functions (SIFs), with the highest level of safety integrity being SIL 4 and lowest being SIL 1. The required SIL of a SIF is derived by taking into account the required risk reduction to be provided by the function.

The following subsections outline the general LOPA methodology for analysing selected scenario from HAZOP and for determining SIL rating of SIF in accordance with the IEC 61508/ 61511.

### Objective

The objective of the Layers of Protection Analysis (LOPA) study is to provide an early indication of whether any protective functions are necessary to be considered as a safety function with a consequential requirement for a Safety Instrumented System (SIS). IRESC will provide an experienced Chairman to facilitate the LOPA study. The typical scope of the study includes all the identified Safety Instrumented Functions (SIFs) on the P&IDs and C&E drawings (and those recommended during HAZOP and finalized to be implemented). As per Project specification, Layers of Protection Analysis for Process Hazards (NOQD 468), all hazardous scenarios in HAZOP with catastrophic consequence severity (Category 4) or high risk ranking will be covered in LOPA..

As per NOQD-468 Layer of Protection Analysis for Process Hazards, LOPA is not required when following is met:

* Consequence severity less or equal to Very Serious (Category 3)
* Residual risk level Low or Very Low has been achieved in HAZOP

### Methodology

The general LOPA procedure is briefly described as follows:

* Identification of SIFs from C&EDs/P&IDs and those recommended from the HAZOP. This step will include identification of initiators and final elements. The SIF purpose (design intent) will also described.
* The LOPA team will select the Target Mitigated Event Likelihood (TMEL) for each consequence scenario, based on consequences on Safety, Environment and Asset.
* The potential demand scenarios (e.g. control loop failure, operator error, etc.) are then identified for the identified SIF, taking inputs from the results of the HAZOP study.
* Quantify initiating cause likelihood based on HAZOP findings and inputs from the LOPA team for each demand scenario. The likelihood will be assigned using the rule set which provides likelihood of failure for typical initiating events encountered during LOPA study. The likelihood will consider initiating event frequency and apply a modification factor (i.e. conditional modifier to account for various factors which can cause demand on the SIF).
* Identify Independent Protection Layers (IPLs) from HAZOP safeguards.
* Quantify Probability to Fail on Demand (PFD) for the identified IPL based on the rule sets.
* Identify and quantify any further condition modifiers or enabling conditions such as ignition probability and chances of operator presence in the area which will affect the likelihood of the hazardous event which SIF is intended to protect against.
* Calculate LOPA ratio for each TMEL, which will give the PFD and thus SIL for the SIF being reviewed.
* Determine Safety Integrity Level (SIL) requirement for the SIF, by selecting the highest SIL rating among the various consequence categories.

# REPORTING

Draft HAZOP and LOPA Review reports and Preliminary SIL classification Report for each unit (i.e., one report each for Unit 20, Hot Oil Furnace (Unit 55 – 56), Unit 40, Unit 46, Unit 80, Unit 60, Unit 61, Unit 51, Unit 81, and Unit 82) will be prepared to include all the findings and recommendations from the study sessions. Study worksheets and other records such as marked up P&ID etc. will be attached to the reports. First draft of the reports will be submitted within one week after the completion of the respective studies. The final reports will be submitted within one week after receiving one set of consolidated comments from Technip/ Owner.

# Study Schedule

Based on our review of PFDs, we have estimated the following duration presented in the Table 6.1.

Table 6.1 Tentative workshop study duration proposed by Technip & IRESC



| No. | Unit | Duration proposed by Technip | Duration estimated by IRESC | Remarks |
| --- | --- | --- | --- | --- |
| 1. | Unit 21: ARU and SWS | 10 days | 7 days | 2 teams: 1st Team for Unit 21 (ARU, SWS and HC section) and 2nd Team for Unit 11, 12, Storage and Utilities |
| 2. | Unit 21: HC section | 20 days | 15 days |
| 3. | Unit 11: HTU  Unit 12: PTU  Unit 42: Storage | 16 days (4 days per week) | 13 days (4 days per week) |
| 4 | Utilities | 15 days | 5 days |
| **Total** | | **13 weeks** | **9 weeks** |  |

One additional week (beyond estimated 9 weeks) may be considered as buffer. As per tentative schedule provided by TechnipFMC Studies are planned to be performed from June to September2018. As per our estimate, it may be possible to schedule the Utilities section as well before the break in August.

IRESC primarily prefers to conduct the HAZOP and LOPA studies in videoconference under stringent requirements from Covid-19 issues. In order to fit the timeframe available into overall project schedule, parallel teams may be arranged if required.

HAZOP schedule will be agreed with Owner and a daily HAZOP Sessions schedule by unit will be provided to Owner for their arrangements in duly advance (two weeks’ notice as a minimum).

As requested, the HAZOP and LOPA studies will begin on 1st of October 2020 and should not extend beyond 4th of November 2020.

# IRESC experience

IRESC possesses highly qualified, multi-disciplinary HSE risk practitioners with global experience in providing independent services for clients in the onshore and offshore, oil & gas and petrochemical sectors. Our team has extensive experience in undertaking process safety, risk and reliability studies of major projects during basic/detailed engineering phase.

Details of IRESC services and experiences are provided in Company Brochure as attached in Annexure A. IRESC Project experience is presented in the following tables.

Table 7.1 IRESC Refinery Project Experience





**Table 7.2 Key Refinery and Petrochemical Experience**

| **Project Name** | **Client** | **Owner** | | **Plant Location** | **Studies Conducted** | |
| --- | --- | --- | --- | --- | --- | --- |
| ***Refinery Projects*** | | | | | | |
| PHA Study (Revalidation) for Neste Singapore Refinery | Neste Singapore Refinery | Neste Singapore Refinery | | Singapore | HAZOP, SIL and AEA | |
| Neste Singapore Expansion Project | Technip Italy S.p.A | Neste Singapore Refinery | | Singapore | HAZOP, SIL | |
| MIDOR Refinery Expansion Project | Technip Italy S.p.A (TPIT) | Middle East Oil Refinery (MIDOR) | | Egypt | HAZOP, SIL Classification (LOPA) | |
| Jebel Ali Refinery Expansion Project | Technip Italy S.p.A | ENOC Processing Company L.L.C. (EPCL) | | Abu Dhabi, UAE | HAZOP, SIL Classification, F&G Mapping | |
| BAPCO Modernization Program  Project | Technip Italy S.p.A | The Bahrain Petroleum Company B.S.C. (BAPCO) | | Bahrain | HAZOP, SIL | |
| Shymkent Refinery Modernization  and Revamping Project | Technip Italy S.p.A | PetroKazakhstan Oil  Products | | Kazakhstan | HAZOP  Units Studied: Saturated /Unsaturated LPG  Sweetening, RFCC, CGOHT, MTBE, C3/C4  Splitter, **ARU, SWS,** SRU and TGTU | |
| Clean Fuel Project (CFP) | Saipem Ltd. (Saipem) | Thai Oil Public Company Limited (TOP) | | Thailand | HAZOP, SIL | |
| Residue Upgradation Unit and SDA Unit Project - Visakh Refinery Modernization Project (VRMP) | L&T Hydrocarbon Engineering Limited | Hindustan Petroleum Corporation Limited (HPCL) | | India | HAZOP, SIL | |
| Shell Philippines Exploration B.V. Project-SIL | Shell Philippines Exploration B.V. (SPEX) | Shell Philippines Exploration B.V. (SPEX) | | Philippines | HAZOP, SIL Classification | |
| Technip-SPRC - Phase 2B/3 and Phase 3 Project (EPC)-PHA/SOA Study | Technip Engineering (Thailand) Ltd. | Star Petroleum Refining Co., Ltd (SPRC) | | Thailand | HAZOP | |
| KT-Petro Rabigh CFP & SRU project | KT – Kinetics Technology | Rabigh Refining and Petrochemical Company (Petro Rabigh) | | Rabigh | HAZID, HAZOP, LOPA | |
| Hindustan Rajasthan Refinery Project | Tata Projects Limited | HPCL Rajasthan Refinery Limited | | India | HAZOP, SIL, Consequence Modelling, EERA, F&G Mapping, SIMOPS | |
| Nghi Son Refinery and Petrochemical (NSRP) Complex Project | GS Engineering & Construction Corporation / JGC Corporation / Chiyoda Corporation  (Multiple EPC execution) | JV Idemitsu Kosan / Mitsui Chemicals / Kuwait Petroleum / PetroVietnam | | Vietnam | HAZOP, SIL Classification (LOPA)   Units Studied: RFCC, RHDS, **Isomerisation**, Alkylation, HGU, **ARU, SWS**, SRU, TGTU, U&O apart from Vendor Packages. | |
| PETRONAS Refinery and Petrochemical Integrated Development (RAPID) Project - Package 1 RFCC | CCJV – Consortium of CTCI Corp., Chiyoda Corp., Synerlitz (Malaysia) Sdn., and MIE Industrial Sdn. Bhd. | PETRONAS Refinery  and Petrochemical  Corporation | | Pengerang, Johor, Malaysia | RAM Study, RCM, HAZID, ENVID, HRA and FSAR Study | |
| PETRONAS Refinery and  Petrochemical Integrated  Development (RAPID) Project -  Package 3 | Technicas Reunidas | PETRONAS Refinery  and Petrochemical  Corporation | | Pengerang, Johor,  Malaysia | FSAR, Construction ENVID, QRA  Refinery Units – SGP,  DHT, KHT, CNHT, **NHT**, CCR, HPU,  RPSA, Refinery Flare, Interconnecting  Unit, IA | |
| PETRONAS Refinery and  Petrochemical Integrated  Development (RAPID) Project –  Package 4 (S SSU & LSU)sulphur  Block - **ARU**, SRU, **SWS** | Petrofac E&C Sdn Bhd | PETRONAS Refinery  and Petrochemical  Corporation | | Pengerang, Johor,  Malaysia | HAZID, ENVID, HER & Bow –tie, LDAR  Program Development, Construction HRA,  Construction ENVID, Construction HIRAC,  RCM, LDAR Study  Units studied: **ARU, SWS,** SRU | |
| Clean Fuels Project - Mina Abdullah Refinery (MAB1), Kuwait | Petrofac, Samsung & CB&I JV | Kuwait National Petroleum Company (KNPC) | | Coastal Zone South OF Kuwait City | HAZOP, SIL Classification (LOPA), SIL Verification, Alarm Management Study  Units Studied: CDU, CCR, HOC, KHT, DHT, VRU, HCR and DHTU | |
| Jazan Refinery and Terminal Project | JGC Corporation / Hitachi Ltd.  (Multiple EPC execution) | Saudi Aramco | | Saudi Arabia | HAZOP, SIL Classification (LOPA), Alarm Management Study  Units Studied: **Naphtha**, Aromatics, **NHT**, Reformer, CCR, C5/ C6 I**somerisation**, P-xylene/ Benzene Extraction Unit apart from Vendor Packages and MOCP. | |
| Pertamina Cilacap Blue Sky Project (PBLC) Project | JGC Corporation | PT Pertamina | | Indonesia | HAZOP, SIL Classification, HAZID | |
| Clean Fuels Project - Mina Al-Ahmadi Refinery (MAA), Kuwait | JGC Corporation / GS Engineering & Construction / SK Engineering & Construction | Kuwait National Petroleum Company (KNPC) | | Coastal Zone South OF Kuwait City | Alarm Management Study  Units Studied: U107 – **Isomer**; U125 - LPG TU, U135 - DCU-**NHTU**, U137 - De-Isopropanizer, U138 - IC5 Merox Unit, U144 – GOD, U146 - De-isobutanizer ,U148 – HPU, U187 - Coke Handling facility ,U129 - Steam System, U141 – ARDS, U150 – HSR, U160 - Interconnecting piping, U162 - Hydrocarbon Flare,VRU,HOC, Water Sytem, Fuel gas System, Fire fighting facilities; DCU, HSR, SWT, Acid Gas FLARE, Steam & condensate | |
| Yansab Butadiene FEED Project | CTCI Corporation | Yanbu National Petrochemical Company (YANSAB) | | Saudi Arabia | QRA, HAZOP,SIL Classification, SRS, Sustainability Compliance Report, Energy Intensity Report | |
| Dangote Refinery Project | Engineers India Limited (EIL) | Dangote Oil Refinery Company Ltd (DORC) | | Nigeria | SIL Classification Study (LOPA) | |
| Rabigh UOI Project, part of Rabigh Refinery Complex | GS Engineering & Construction Corporation | Saudi Aramco / Sumitomo Chemical Company | | Saudi Arabia | HAZOP, SIL Classification (LOPA)  Units Studied: HP/LP Flare, Sea Water System, Loading Arms, Electro-chlorination Package, Cooling tower, Metering Package and Chemical Injection | |
| Saudi Kayan EOEG Debottlenecking DBN FEED Project | CTCI Corporation | Saudi Kayan | | Saudi Arabia | QRA, HAZOP, SIL, Safety Requirement Specification, Sustainability Review, Inherent Safety Design Review | |
| EO/EG Debottlenecking Project | Wilson Engineering | Saudi Arabic Basic Industries Corporation (SABIC) | | Saudi Arabia | HAZOP, SIL | |
| EO/EG Debottlenecking Project | Wilson Engineering | Saudi Kayan Petrochemical Company | | Saudi Arabia | SIL Verification | |
| Jazan Refinery and Marine Terminal Project EPC-13 Utility Package | Hitachi, Ltd. | Saudi Aramco | | Saudi Arabia | Technical Review, SIL Verification | |
| Aishwarya Project | Punj Lloyd Limited (PLL) | Indian Oil Corporation Limited | | India | HAZOP & SIL Study | |
| Aishwarya Project - Offsite and Utilities | Punj Lloyd Limited (PLL) | Indian Oil Corporation Limited | | India | HAZOP & SIL Study | |
| Haldia Refinery EPCC-2 Aishwarya Project | Punj Lloyd Limited (PLL) | Indian Oil Corporation Limited (IOCL) | | India | HAZOP, SIL Classification | |
| Takreer Abu Dhabi - CBDC Project | Samsung Engineering Co. Ltd. | Abu Dhabi Oil Refining Company | | Abu Dhabi, UAE | HFE | |
| ***Onshore – Petrochemical Projects*** | | | | | | |
| SOCAR GPC Project | Technip Italy S.p.A. | SOCAR GPC Limited | | Garadagh, Azerbaijan | Coarse Hazard and Operability  (HAZOP) Study | |
| Mangalore PTA Plant Project | Technip India Ltd. | JBF Petrochemicals | | India | HAZOP, SIL Classification | |
| JG Summit Stage 1 Expansion Project | POSCO E&C | JG Summit Petrochemical Corporation | | Philippines | HAZOP, SIL Classification Study (LOPA) ; MOC HAZOP/;SIL ; SIL Verification Study; SRS; Noise Study; AIV Study; Vent Dispersion and Radiation study; Valve Criticality Analysis; ARS, Construction HAZID; SIMOPS Study; FSA study; Update of the existing EIA study report | |
| JG summit expansion pkg2 project-HSE Studies | CTCI Corporation | JG Summit Petrochemical Corporation | | Philippines | HAZOP, SIL Review, Construction/SIMOPS HAZID, ARS, Physical Effects Modelling, FSA, SRS | |
| Master Agreement services with Huntsman to support on various HSE requirements for their asset in Asia | Huntsman Advance Materials Limited | Huntsman Advance Materials Limited | | All Huntsman Plants in Asia | HAZOP, LOPA, SIL Verification and other safety and risk studies | |
| Wanhua US MDI Complex Project | Fluor USA | Wanhua Chemical US Holding Inc. | | China | HAZOP,SIL Classification | |
| PETRONAS Refinery and  Petrochemical Integrated  Development (RAPID) Project -  Package 11EO/EG | Samsung Engineering Co.  Ltd. | PETRONAS Refinery  and Petrochemical  Corporation | | Pengerang, Johor,  Malaysia | HAZOP, HAZID, ENVID, HRA Studies,  Bowtie Analysis, CAC, SCE & PS,  Design HSE Case, Fire Protection &  FGS 3D detection review and  Hazardous Area Classification Review | |
| PETRONAS Refinery and  Petrochemical Integrated  Development (RAPID) Project -  Package 6A LLDPE | Samsung Engineering Co.  Ltd. | PETRONAS Refinery  and Petrochemical  Corporation | | Pengerang, Johor,  Malaysia | HAZID, ENVID, HRA Studies, Bowtie Analysis,  CAC, SCE & PS, Design HSE Case, Fire  Protection & FGS 3D detection review and  Hazardous Area Classification Review | |
| PTTGC Olefins Reconfiguration Project | Samsung Engineering Co. Ltd | PTT Global Chemical Public Company Limited (PTTGC) | | Map Ta Phut, Rayong Province in Thailand | HAZID, ENVID, HAZOP, SIL Classification, SRS, QRA, FSA | |
| NPC TX828KTA EG-2 Project | CTCI Corporation | Nan Ya Plastics Corporation (NPCA) | | Point Comfort, Texas, USA | HAZOP, SIL Classification (LOPA) study | |
| Asahimas Phase VI Project- VCM Plant | Hyundai Engineering Co. Ltd. | P.T. Asahimas Chemical | | Indonesia | HAZOP, SIL Classification (LOPA), SIL Verification | |
| GC Oxirane Propylene Oxide Project | Samsung Engineering Co., Ltd. (SECL) | PTT Global Chemical Public Company Limited | | Thailand | HAZOP, SIL, SRS, QRA and FSA  (Ongoing Project) | |
| Shintech Ethane Cracker Plant Project | Toyo Engineering Corporation | Shintech | | Plaquemine, LA, U.S.A | BRA, CA, HAZOP, SIL Classification, HIPS, SIL Verification Studies | |
| Formosa Texas Olefins-III | Toyo Engineering India Limited / Toyo Engineering Corporation  (Multiple EPC execution) | Formosa Plastics Corporation | | USA | HAZOP, SIL Classification (LOPA) and SIL Verification | |
| Butanol & Syngas Project | Daelim Industrial Co., Ltd. | Saudi Butanol Company | | Saudi Arabia | HAZOP, SIL Classification | |
| SMC Methanol Plant Project | Salah Methanol Company (SMC) | Salah Methanol Company (SMC) | | Oman | HAZOP, LOPA | |
| Performance Product Unit - Ankleshwar | Huntsman Advance Materials (Hong Kong) Limited | Huntsman (International) India Pvt. Ltd. | | - | HAZOP, SIL Classification (LOPA) | |
| ASB-Biodiesel plant project | ASB Biodiesel Plant (Hong Kong) Limited | ASB Biodiesel Plant (Hong Kong) Limited | | Hong Kong | SIL Study & Gas Mapping Study | |
| Additional Pre-Heaters of EDC Cracker in VCM-2 Plant Project | PT Asahimas Chemical (ASC) | PT Asahimas Chemical (ASC) | | Indonesia | SIL Classification Study | |
| Refrigerated Gaseous Tank Facility (RGTF) for Ethylene and Propylene | Chiyoda Singapore (PTE) Limited | Dialog Plant Service SDN. BHD. | | Malaysia | HAZID, HAZOP, SIL Classification, SIL Verification, ECA, RAM, F&G Mapping Cryogenic Spill Protection, Atmospheric Vent Dispersion, Noise Survey | |

***Terminology:***

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ALARP | : | As Low as Reasonably Possible | HAZOP | : | Hazard and Operability | NHHA | : | Non-hydrocarbon Hazard Analysis |
| BRA | : | Blast Risk Assessment | HAZID | : | Hazard Identification | RBI & RCM | : | Risk-based Inspection & Reliability Centered Maintenance |
| DOS | : | Dropped Object Study | HER & BTA | : | Hazards and Effects Register & Bow-tie Analysis | RAM | : | Reliability, Availability and Maintainability |
| ENVID | : | Environmental Impact Identification | HSE | : | Health, Safety and Environment | SIL | : | Safety Integrity Level (includes LOPA, IPF and risk matrix style assessments) |
| ESSA | : | Emergency Systems Survivability Analysis | HAZCON | : | Hazards of Construction | SRS | : | Safety Requirement Specifications |
| EERA | : | Escape, Evacuation and Rescue Analysis | HFE | : | Human Factors Engineering | SIMOPS | : | Simultaneous Operation |
| FRA | : | Fire Risk Assessment | HRA | : | Health Risk Assessment | SGIA | : | Smoke and Gas Ingress Analysis |
| FERA | : | Fire and Explosion Risk Assessment | LDAR | : | Leak Detection and Repair Program | SCE&PS | : | Safety Critical Elements & Performance Standards |
| F&G | : | Fire & Gas | MI | : | Mechanical Integrity | TRA | : | Thermal Radiation Analysis |
| FMEA | : | Failure Mode Effects Analysis | PEA | : | Probabilistic Explosion Analysis | WSE | : | Written Scheme of Examination |
| GDM | : | Gas Dispersion Modelling | QRA | : | Quantitative Risk Assessment |  |  |  |

We believe that for safety and risk studies, the capability of a company is attributed to the experience of its staff. Our staff has a well-established reputation with a variety of experiences in areas such as process design and operation, process safety and risk assessment of different industry sectors (e.g. Processing Facilities, Offshore Facilities, Refinery, Oil & Gas, and Petrochemical etc.).

We have full capability to provide the following services:

* Hazard Identification (HAZID) study;
* Hazard and Operability (HAZOP) study;
* Safety Integrity Level (SIL) study;
* Quantitative Risk Assessment (QRA) study;
* Onshore and Offshore Formal Safety Studies, Health, Safety and Environmental Impact Assessment (HSEIA);
* Escape, Evacuation and Rescue Analysis (EERA) and Emergency System Survivability Analysis (ESSA) study;
* Reliability, Availability and Maintainability studies (RAM), Failure Modes and Effects Analysis (FMEA) and Reliability Centered Maintenance (RCM);
* Layer of Protection Analysis (LOPA), SAFOP and eHAZOP studies, and preparation of Safety Requirement Specifications (SRS);
* Acoustic Induced Vibration (AIV) and Noise & Vibration studies;
* Human Factor Engineering (HFE) study;
* Gas Dispersion Study;
* Consequence Analysis, Fire and Explosion Analysis (FEA), Explosion Overpressure Analysis, including full probabilistic analysis with FLACS;
* Fire Risk Assessment ;
* Building Risk Assessment;
* Alarm Management Study/Alarm Objective Analysis;
* Environmental Impact Identification (ENVID), Occupational Health Risk Assessment (OHRA), Dispersion modelling including advanced 3D techniques and Exhaust and Vent Dispersion Studies, Flare radiation studies

We believe that IRESC, with such a strong specialist team, will strive to help Technip successfully deliver on this Project.

# Proposed Study Team



IRESC would request approval of all nominated chairman to accommodate the schedule. This is also in the best interest of the project, in case either chairman is not able to attend the study due to unforeseen reason, back-up chairman will still be available to cover the workshops for these studies and thus not affecting the schedule.

In case confirmation of service award to IRESC is less than 2 weeks from the start date of sessions, IRESC reserve the option to propose alternate facilitators, of similar experience, subject to availability.

The following paragraphs provide the synopsis of the experience of our key team members. Detailed CVs of the proposed personnel are attached to Annexure B for consideration.

**Debabrata Panda**

Mr. Debabrata Panda has 14+ years of overall experience in safety and risk analysis studies such as Hazard Identification (HAZID), Simultaneous Operations (SIMOPS), Hazard and Operability (HAZOP) studies, Safety Integrity Level (SIL) Classification Studies, Alarm Management Studies (AMS), Consequence Modelling, RAM, Safety Layout Reviews, plot plan reviews, and Quantitative Risk Assessment (QRA). In addition to process safety studies, he was involved in process design activities for offsite storage and transfer facilities for oil and gas installations. Further, he has been associated in commissioning/start-up for units in various refineries.

In addition to process safety studies, he was involved in process design activities for offsite storage and transfer facilities for Refinery, Petrochemical Complex and LNG Re-gas Terminal. Further, he has been associated in commissioning/start-up for various oil and gas installations.

He is a Certified Functional Safety Expert (CFSE) from CFSE Governance board in 2017.

Some of the key projects include:

* HAZOP, LOPA and Action Error Analysis (AEA) Study (revalidation study of existing refinery units) for NExBTL Unit including SWS and ARU, Hot Oil and Flare system Neste Singapore Refinery, 2019-20
* HAZOP and LOPA study for ARU, SWS and NExBTL Unit for NESTE-Singapore Refinery Expansion Project, 2018-19
* HAZOP Study for Refinery Fuel Gas System and other facilities for BAPCO Modernization Project, BAPCO Refinery, 2019. Also, led the Alarm Rationalization Study for the project, 2020
* HAZOP and SIL Study for NHT, CCR and PAR-ISOM Unit of New Naphtha Complex Project, Corinth Refinery, Motor Oil, Greece, 2019
* Revalidation HAZOP study for High Olefin Fluid Catalytic Cracking Unit (HOFCC) for Petro Rabigh, KSA, 2018
* HAZOP study for Naphtha Cracker Unit (Olefin Reconfiguration Project) for PTTGC, Thailand, 2018
* HAZOP and SIL Study for Naphtha Cracker Revamp Project, QAPCO, Qatar, 2019
* HAZOP and SIL Study for Gas Separation Plant Train-1, PTTGSP, Rayong, Thailand
* SIL Classification Study (LOPA) for various process units (RFCC, Hydrocracker, MS Block, HGU) and offsite storage and utility facilities for Dangote Oil Refining Company, 2017
* SIL Classification Study for Sulphur Block, IOCL Haldia Refinery, 2016
* HAZID, SIMOPS, HAZOP & SIL Classification for Phase-IIIB1 expansion project, LNG Dahej Terminal, PLL
* HAZOP and SIL Study for Vendor Packages for Propane Dehydrogenation Unit (PDH), Kazakhstan Petrochemical Industries Inc.
* HAZOP Study for New Power Plant, Asahimas Chemical Company (ASC), 2017
* HAZOP Study for XQST FSRU Project, Excelerate, 2019
* HAZOP and SIL Classification study for vendor packages for MV-31 FPSO, Petrobras
* SIL Classification Study (LOPA) Angola Block 15/06 East Hub Development Project (FPSO), Eni Angola S.p.A., 2015
* HAZID and HAZOP Study for Bir Seba Project Gas Tie-in Project, GBRS, JGC Algeria, 2016, Owner: SOANTRACH Algeria
* HAZID, HAZOP and SIL Study for Floating Production Unit (FPU) Upgrade, Jangkrik under Merakes Development Project. Owner: ENI East Sepinggan Ltd, Indoneisa

HAZID study for Jangkrik Floating Production Unit (FPU) for Debottlenecking Study, 2018, ENI Muara Bakau B.V, Indonesia, 2018

**Rajeev Khurana**

Mr. Rajeev Khurana graduated with bachelor’s degree in Chemical Engineering. His overall experience is 12+ years in the field of Process design and safety. He has expertise in Process Safety, particularly experienced in Hazard & Operability (HAZOP), SIL Classification, LOPA, Alarm Management, HAZID/ENVID and Human Factor Engineering (HFE) studies. He has a wide range of experience in facilitating related workshops apart from executing various HSE & engineering studies for major oil and gas projects. These studies were performed either directly on behalf of the Owner or in support of the FEED or Detail Engineering Contractor.

He has also conducted various environmental studies for various refinery majors in India and also for global oil and gas clients. He has also undertaken Projects involving dispersion modeling, Environment Impact Assessment (EIA) studies, and water pinch studies along with design of water treatment systems / incinerators / thermal oxidizers. As part of his work assignment he has also been involved in commissioning / operation activities List of few key facilities where he was actively involved in delivering HSE workshops/ studies are listed below for quick reference, followed by detailed synopsis in Annexure B.

* HAZOP/LOPA for Neste NEXBTL Refinery Expansion Project, Singapore – EPC Stage Study including Vendor Packages, Technip FMC, Rome;
* HAZOP/LOPA study for Thai Oil Refinery Expansion Project, EPC Phase, Saipem, Milan (using SHELL SIF Pro Software);
* HAZOP/SIL Classification for MIDOR Refinery Expansion Project, EPC Phase study including Vendor Packages, Technip Rome;
* HAZOP/LOPA for Duqm Refinery Project - EPC Package 2, Oman - Offsite and Utilities including Vendor packages, Petrofac, Sharjah;
* HAZOP Study for VOC Collection and Treatment System, MRPL, India;
* HAZOP Study for Incinerator Package, IOCL, Paradip Refinery, India
* HAZID, ENVID & HRA Studies for Rapid Package 11 for Ethylene Oxide and Ethylene Glycol Unit. Client: Samsung Engineering, Seoul, Korea, Owner: PETRONAS
* HAZID study for PETRONAS RAPID Package 4 for ARU, SRU, SSU, SWS and LSSU. Client: Petrofac, Malaysia, Owner: PETRONAS
* HAZID study for PETRONAS RGT2 LNG Terminal facilities. Client: AMEC Foster Wheeler, Owner: PETRONAS GAS.Alarm Rationalization Study for PETRONAS RAPID Project Package 1, CCSM Joint Venture, Taipei, Taiwan
* SIL Classification Study for SRU, SWS and ARU for IOCL Haldia - Aishwarya Project, Punj Lloyd Engineering, New Delhi
* Human Factors Engineering Study for Onshore Terranganu Gas Terminal (TGAST) Development Project, PETRONAS Carigali
* Human Factor & Ergonomics study for Carbon Black & Delayed Coker (CBDC) Project owned by Abu Dhabi Oil Refining Company (Takreer)

**Amit Kalra**

Mr. Amit Kalra has 13 years of experience and worked as a Process/ Operations engineer mainly in the refinery & petrochemical industrial sectors for Pre-commissioning, Commissioning, Process operations, Project leadership. He has expertise in Plant commissioning, Interlock checking, Emergency handling, Hazard and Operability (HAZOP) study, Safety Integrity Level (SIL)/ IPF classification study, Human Factor Engineering (HFE) Study and Alarm Management Study (AMS).

He is particularly experienced in optimization, control & improvement with emphasis on Motor Spirit units such as Naptha Hydrotreater unit, Continuous Catalytic Reforming unit, Isomerization unit and Hexane Recovery unit. He has operation and commissioning experience in refinery units.

He is a Certified Functional Safety Professional from the CFSE Governance Board. Some of the key projects he has worked on include:

* HAZOP and LOPA study for Hydrogen Production Unit (HPU), Utilities, Hot Oil & Heat Treatment Unit of new NESTE expansion project NxBTL, Singapore for Technip Italy.
* HAZOP and SIL study of new Hydrocracker Unit of Middle East Oil Refinery, Egypt for Technip Italy.
* HAZOP and SIL study of revamped Hydrocracker Unit of Middle East Oil Refinery, Egypt for Technip Italy.
* HAZOP study of Naptha Hydrotreator Unit (Licensor Axens) of JEBEL ALI Refinery Expansion Project of ENOC Processing Company LLC for Technip Italy.
* Revalidation HAZOP for Vacuum Gas Oil Unit of Rabigh Refining and Petrochemical Company.
* SIL study of Diesel Hydrotreator/Kerosene Hydrotreator Unit (Licensor UOP), Naptha Hydrotreator Unit (Licensor Axens), Isomerization (Licensor UOP), Condensate Distillation Unit of JEBEL ALI Refinery Expansion Project of ENOC Processing Company LLC for Technip Italy.
* Fire & Gas Mapping study for the Naptha Hydrotreator Unit (Licensor Axens) of JEBEL ALI Refinery Expansion Project of ENOC Processing Company LLC for Technip Italy.
* HAZOP study of Condensate Distillation Unit and Middle Distillate Unit of ADISH Siraf Condensate Refinery Project for PIELDS Engineering.
* HAZOP study of Continuous Catalytic Regeneration Unit of PERTAMINA Cilacap Blue sky Project for JGC Indonesia.
* HAZOP and SIL study of revamped Platformer Unit (Licensor UOP) of PERTAMINA Cilacap Blue sky Project for JGC Indonesia.
* SIL study of Condensate Distillation Unit, Middle Distillate Unit, Naphtha Hydrotreating Unit, LPG Treating Unit, LPG Recovery Unit and Storage of ADISH Siraf Condensate Refinery Project for PIELDS Engineering.
* HAZOP study of Heater Package of Euro 4M project for Hengyuan Refining Co SDN BHD.
* HAZOP and SIL study of both Hydrocracker Units of Clean Fuel Project Mina Abdullah Refinery, Kuwait National Petroleum Company for Petrofac.
* Re-HAZOP & LOPA study for the Utilities & Offsite sections of the Methanol plant of Salalah Methanol Company, Oman.
* SIL Validation of VRU package of NASR Full Field Development Project of ADMA- OPCO for HHI.
* SIL Verification of NASR Full Field Development Project including Vendor Packages, ADMA-OPCO for HHI.
* Vendor HAZOP and SIL study of Hydrocracker units, Diesel Hydrotreater units, Continuous Catalytic Reforming Unit and Crude Distillation Unit of Clean Fuel Project Mina Abdullah Refinery, Kuwait National Petroleum Company for Petrofac.
* HAZOP study of NHT, CCR, ISOM units of Bharat Oman Refineries Limited, India.
* Re-HAZOP study of NHT, CCR, and ISOM units of Hindustan Mittal Energy Limited, India.
* SIL study of Petronet Dahej LNG Receiving Terminal Expansion project phase- IIIA, India for TOYO.
* HAZID & SIMOPS study of BP Tangguh Expansion Train-3 Project, Indonesia for Chiyoda Saipem Tripatra SAE (CSTS).
* SIMOPS study of PTT LNG Receiving Terminal Expansion Project Phase-II, Map Ta Phut, Thailand for POSCO.
* SIMOPS study of Petronet Dahej LNG Receiving Terminal Expansion project phase-IIIA, India for TOYO.
* SIL Verification study of Hydrocracker units, Diesel Hydrotreater units, Continuous Catalytic Reforming Unit and Crude Distillation Unit of Clean Fuel Project Mina Abdullah Refinery, Kuwait National Petroleum Company for Petrofac.
* Alarm Management Study of Hydrocracker units, Diesel Hydrotreater units, Continuous Catalytic Reforming Unit, Hot Oil Unit and Kerosene Hydrotreater Unit of Clean Fuel Project Mina Abdullah Refinery, Kuwait National Petroleum Company for Petrofac.
* HAZOP and SIL study of Shaybah CPF Expansion project, Saudi Aramco for SECL.
* HAZOP and SIL study of Vendor Packages of Shaybah CPF Expansion project, Saudi Aramco for SECL.
* Alarm Management Study for Jazan Integrated Gasification Combined Cycle (JIGCC) Power Plant Project, Saudi Arabia for SEPCO.
* Alarm Management Study for Jazan Refinery & Terminal Project, Saudi Arabia.
* Alarm Management study for HMEL, India.
* AMS study of HSR unit for Clean Fuels Project of KNPC for JGC, SK Engineering and GS engineering JV.
* 3D model review & DCS graphic review for HMEL, India.
* NHT, CCR, ISOM & HRU commissioning in HPCL Mittal Energy Limited, India.
* Grass root refinery commissioning of Bharat Oman Refineries Limited, India.

**Dennis Ngai**

Mr. Ngai is a chemical engineer, with over 13 years of experience in leading Quantitative Risk Assessment (QRA), occupied building risk assessment, fire, explosion and toxic effects modelling, cost-benefit analysis, HAZOP, SIL & LOPA studies, and safety case studies.

Mr. Ngai experience covers a wide range facilities, including oil refinery, LNG plants, gas processing plant, offshore platform, cross-country / subsea pipelines, olefin / cracker plant, and polymer (including EOEG and LDPE) production.

Particularly in the LNG sector, Mr. Ngai has carried out many QRA and process safety studies for facilities all over the world (both receiving terminals and production facilities), including Hong Kong, Thailand, Malaysia, Singapore, Dubai, India, Russia, Shanghai, Canada, the US and Australia. Thus, he has developed an in-depth knowledge of LNG processes, the related standards including NFPA 59A and EN 1473, and the country-specific risk / safety requirements. Mr. Ngai led a consultancy study to develop a QRA guideline for the Hong Kong Government. Mr. Ngai also acted as the Singapore Government’s consultant and contributed to the existing QRA guideline in Singapore (enacted in 2016).

Mr. Ngai is also a competent facilitator for HAZID, HAZOP, SIL & LOPA studies as well as other process safety workshops. He is a Certified Functional Safety Professional by the CFSE Governance Board. Some of the HAZOP studies chaired by Mr. Ngai are listed below.

* HAZOP and LOPA for Neste Singapore Refinery (Renewable Fuel Refinery) Expansion Project – feedstock pretreatment facilities, tankage and vendor packages including furnace, chiller and dosing system, in support of TechnipFMC, Italy
* HAZOP and SIL for utilities and tie-in for Middle East Oil Refinery (MIDOR) Expansion project in Egypt , in support of TechnipFMC, Italy
* HAZOP for BAPCO Modernization Program (BMP) – existing refinery tie-in and integration, in support of TechnipFMC, Italy
* Formosa Sunshine Project - FEED HAZOP and LOPA for EG 1 process units (OMEGA Process by Shell Global Solutions) in the USA
* LOPA and HAZOP for a Caprolactam Production Plant (re-HAZOP for operating plant) in China, in support of TianChen Engineering Corporation
* Design HAZOP and LOPA of EOEG plant (TX-EG project) in Texas.
* Inherently Safer Design Review for Saudi Kayan EOEGO plant debottlenecking Project and SABIC Yansab Butadiene Project
* HAZOP, SIL, and Inherently Safety Review for SABIC Yansab Butadiene Project, Saudi Arabia, covering debutanizer (Lummus Technology) of Yanpet Ethylene Cracker, Butene-1 Plant (UOP technology), and Butadiene plant (SABIC technology); also participated in the Sustainability Workshop as the sustainability study consultant.
* HAZOP study for Excelerate Explorer LNG FSRU (DUSAB LNG Terminal), Dubai
* HAZOP for Bohua Polypropylene Plant Project (Vendor Package) in China, in support of TianChen Engineering Corporation, China
* HAZOP for Integrated Petrochemical Complex in Atyrau Region, Kazakhstan – ethylene, propylene and additive feed systems for polypropylene plant
* HAZOP for Chlorine generation system (vendor package) PTT Nong Fab LNG Receiving Terminal in Thailand, in support of Saipem and CTCI JV
* HAZOP and HAZID for 30” subsea gas pipeline from Salman Platform to Sirri Island (FEED project) for Iranian Offshore Oil Company (IOOC).
* HAZOP study for Aseagas Biomethanation Plant, including the feed preparation facilities, Bio-reactors, flare (open flare and ground flare), power generation units and utilities systems.

# Iresc Quality Management System

IRESC has established and implemented a Quality Management System in accordance with the requirements of the ISO 9001:2015. It has been independently audited by third party consultant, Bureau Veritas and has been certified by United Kingdom Accreditation Service (UKAS).

**Annexure A – Company Brochure**

**Annexure B – Curriculum Vitas of the Proposed Study Team**

**Annexure C 1 – CV and Sample Worksheet for Amit Kalra**

**Annexure C 2 – CV and Sample Worksheet for Anand Pednekar**

**Annexure C 3 – CV and Sample Worksheet for Debabrata Panda**