FORMAT NO. : HSE-1 REV 1

(Sheet 4 of 6)

SL. NO.	ITEM	Satisfactory/ Yes	Non satisfactory/ No	Remarks	Action
10.	TEMPORARY FACILITIES				
a)	Emergency instructions posted				
b)	Fire extinguishers provided				
c)	Fire-aid equipment available				
d)	Secured against storm damage				
e)	General neatness				
f)	In accordance with electrical requirements				
g)	Other				
11.	FIRE PREVENTION				
a)	Personnel trained& instructed to make use of facility				
b)	Fire extinguishers checked periodically & record maintained				
c)	No smoking in Prohibited areas.				
d)	Fire Hydrants not obstructed				
e)	Regular fire drill conducted				
12.	ELECTRICAL				
a)	Use of 3-core armored cables everywhere				
b)	Usage of 'All insulated' or 'double-insulated' electrical tools				
c)	All electrical connection are routed through ELCB				
d)	Natural Earthing at the source of power (Main DB)				
e)	Continuity and tightness of earth conductor				
f)	Effective covering of junction boxes, panels and other energized wiring places				
g)	Ground fault circuit interrupters provided				
h)	Prevention of tripping hazards maintained				
f)	DCP extinguishers arranged & licensed electrician engaged at site				

Safety walk-through performer (Name &Signature).....

FORMAT NO. : HSE-1 REV 1

(Sheet 5 of 6)

SL. NO.	ITEM	Satisfactory/ Yes	Non satisfactory/ No	Remarks	Action
13.	HANDLING AND STORAGE OF MATERIALS				
a)	Safely stored or stacked				
b)	Passageways clear / free from obstructions				
c)	Fire fighting facility in place				
14.	FLAMMABLE GASES AND LIQUIDS				
a)	Containers clearly identified / protected from fire				
b)	Safe storage & transportation arrangement made				
c)	Fire extinguishers positioned nearby				
d)	Facilities kept away from electric spark, hot spatters & ignition source.				
15.	WORKING AT HEIGHT				
a)	Approved Erection plan and work permit in place				
b)	Safe access, Safe work platform & Safety nets provided				
c)	Life lines, Fall arrester, Full body harness with double lanyards used;				
d)	Health Check record available for workers going up?				
e)	Protective handrails arranged around floor openings				
16.	CONFINED SPACE				
a)	Work Permit obtained from requisite authority				
b)	Test for toxic gas and sufficient availability of oxygen conducted & status				
c)	Supervisor present at site & at least one person outside the confined space for monitoring deputed				
d)	Availability of safe means of entry, exit and ventilation (register for entry & exit maintained)				
e)	Fire extinguisher and first-aid facility ensured				
f)	Lighting provision made by using 24V Lamp				
g)	Proper usage of PPEs ensured				
17.	RADIOGRAPHY				
a)	Proper storage and handling of source as per BARC/ AERB guidelines (authorized radiographer available)				
b)	Work permit obtained				

Safety walk-through performer (Name &Signature).....

FORMAT NO. : HSE-1 REV 1

(Sheet 6 of 6)

SL. NO.	ITEM	Satisfactory/ Yes	Non satisfactory/ No	Remarks	Action
c)	Cordoning of the area done				
d)	Use of appropriate PPE's ensured				
e)	HSE training to workers/supervisors imparted during the fortnight (indicate topic)				
f)	Minimum occupancy of workplace ensured				
18.	HEALTH CHECKS				
a)	All Workers medically examined and found be fit for working at heights (slinging, rigging, painting etc.) in confined space in excavation / trenching in shot blasting				
b)	Availability of First Aid box with contents				
c)	Proper sanitation at site, office and labour camps				
d)	Arrangement of medical facilities.				
e)	Measures for dealing with illness at site & labour camps.				
f)	Availability of Potable drinking water for workmen & staff.				
g)	Provision of crèches for children.				
h)	Stand by vehicle / ambulance available for evacuation of injured				
i)	Adherence to Govt. Guidelines/procedures during epidemic and pandemic (as applicable).				
19.	ENVIRONMENT				
a)	Chemical and Other Effluents properly disposed				
b)	Cleaning liquid of pipes disposed off properly				
c)	Seawater used for hydro-testing disposed off as per agreed procedure				
d)	Lubricant Waste/Engine oils properly disposed				
e)	Waste from Canteen, offices, sanitation etc. disposed properly				
f)	Disposal of surplus earth, stripping materials, Oily rags and combustible materials done properly				
g)	Green belt protection				

Safety walk-through performer (Name &Signature).....

FORMAT NO. : HSE-2 REV 0

(Sheet 1 of 3)

ACCIDENT REPORT

(To be submitted by Contractor after every Accident within 24 hours to EIL/ Owner)

Report No.: _____ **Date:** _____

Project site: _____ **Name of work:** _____

Contractor's name: _____ Contractor's Job Engineer (name) _____

Non-disabling injury (Non-LTI)	Hospitalized but resumed duty before end of 48 hrsof accident	
Disabling injury (other LTI)	Hospitalized & failed to resume duty within next 48 hrs	
Fatal (LTI):	Death / Expiry	
First Aid case	Resume duty after first aid	

Name of the injured:_____ Father's name of victim: _____

Sub Contractor's Name: .....

Gate Pass No.:.....Age: _____Yrs. Victim's medical fitness exam. (Pre-empl.) date: - _____

Date & time of Accident / Incident: _____

Names of Witnesses: (1_____ (2)_____ (3) _____

Profession of victim:

Bar bender		Carpenter		Meson	
Fitter		Helper		Gas cutter	
Grinder		Welder		Electrician	
Driver		Rigger		M/c.operator	
Engineer		Manager		Other/specify	

Qualification

No formal education		Non-Matriculate		Matriculate	
Graduate		Post- grad		Other/specify	

Job Experience

NIL		Less than 2 yrs		2-5 yrs	
5-10 yrs		11-15 yrs		15 years and above	

Location where the incident happened: _____

_____

FORMAT NO. : HSE-2 REV 0

(Sheet 2 of 3)

Activity / Works that were continuing during incident / accident: -

Excavation		Demolition		Concrete carrying	
Concrete pouring		Transportation of materials (manually)		Transportation of materials (mechanically)	
Work on or adjacent to water		Work at height (+2.0 mts)		Scaffold preparation	
Scaffold dismantling		Piling works		Welding	
Grinding		Gas-cutting		Pipe fit-ups & fabrication	
Structural fabrications		Machine works		Hydro-testing works	
Electrical works		Erection activities		Other/specify	

What exactly the victim was doing just before the incident / accident? .....

.....

.....

Nature of injury:

Bruise or Contusion		Abrasion (superficial wound)		Sprains or strains	
Cut or Laceration		Puncture or Open wound		Burn	
Inhalation of toxic or Poisonous fumes or gases		Absorption		Amputation	
Fracture		Other/specify			

Parts of body involved in incident / accident

Head		Face		Eyes	
Throat		Arm (above wrist)		Hand (including wrist)	
Fingers		Truck (Abdomen / Back / Chest / Shoulder)		Throat	
Leg (above ankle)		Foot (incl. ankle)		Toes	
Multiple				Other/specify	

Accident type:

Struck against		Struck by		Fall from Elevation	
Fall on same level		caught in		caught under	
caught in between		Rubbed or abraded		Contact with (Electricity)	
Contact with (Temp./ extremes)		Contact with chemicals oroils		Vehicle accident	
Other/specify					

FORMAT NO. : HSE-2 REV 0

(Sheet 3 of 3)

Medical Aid provided:-(indicate specific aids / treatment etc.)-

.....

.....

Actions taken to prevent recurrence of similar incident / accident:.....

.....

.....

.....

.....

.....

.....

Intimation to local authorities (Dist. Collector / Local Police Station / ESI authority): Yes / No / NA.

If yes, to whom .....

Safety Officer
(Signature and Name)
Stamp of Contractor

Site Head / Resident Construction Manager
(Signature and Name)

To : Owner
: RCM/Site-in-charge EIL (3 copies)
- Nodal Officer HO through RCM (In case of major accident)
- Divisional Head (Constn) through RCM
- Project Manager, EIL, through RCM

FORMAT NO. : HSE-3 REV 0

(Sheet 1 of 5)

SUPPLEMENTARY ACCIDENT INVESTIGATION REPORT
TICK THE APPROPRIATE ONEAS APPLICABLE (furnish within 72 hours)

Supplementary to Incident / Accident Report No: _____ (Copy enclosed)

Report No.: _____ **Date:** _____

Project site: _____ **Name of work:** _____

Contractor's name: _____ Contractor's Job Engineer (name) _____

Non-disabling injury (Non-LTI **)**	Hospitalized but resumed duty before end of 48 hrs of accident.	
Disabling injury (other LTI**)**	Hospitalized & failed to resume duty within next 48 hrs.	
Fatal (LTI)	Death / Expiry	
First Aid case	Resume duty after first aid	

Name of the injured: _____ Father's name of victim: _____

Sub Contractor's Name: .....

Gate Pass No.:..... Age: _____Yrs. Victim's medical fitness exam. (Pre-empl.) date: - _____

Date & time of Accident / Incident: _____

Names of Witnesses: (1_____ (2)_____ (3) _____

Profession of victim:

Bar bender		Carpenter		Meson	
Fitter		Helper		Gas cutter	
Grinder		Welder		Electrician	
Driver		Rigger		M/c. operator	
Engineer		Manager		Other/specify	

Qualification

No formal education		Non-Matriculate		Matriculate	
Graduate		Post- grad		Other/specify	

Job Experience

NIL		Less than 2 yrs.		2-5 yrs.	
5-10 yrs.		11-15 yrs.		15 years and above	

Location where the incident happened: _____

_____

FORMAT NO. : HSE-3 REV 0

(Sheet 2 of 5)

Activity / Works that were continuing during incident / accident: -

Excavation		Demolition		Concrete carrying	
Concrete pouring		Transportation of materials (manually)		Transportation of materials (mechanically)	
Work on or adjacent to water		Work at height (+2.0 mts)		Scaffold preparation	
Scaffold dismantling		Piling works		Welding	
Grinding		Gas-cutting		Pipe fit-ups & fabrication	
Structural fabrications		Machine works		Hydro-testing works	
Electrical works		Erection activities		Other/specify	

What exactly the victim was doing just before the incident / accident? .....

.....

.....

Particular of tools & tackles being used and condition of the same after incident/accident:

.....

.....

Description of Incident/Accident (How the incident was caused) : .....

.....

.....

.....

Nature of injury:

Bruise or Contusion		Abrasion (superficial wound)		Sprains or strains	
Cut or Laceration		Puncture or Open wound		Burn	
Inhalation of toxic or Poisonous fumes or gases		Absorption		Amputation	
Fracture		Other/specify			

Parts of body involved in incident / accident

Head		Face		Eyes	
Throat		Arm (above wrist)		Hand (including wrist)	
Fingers		Truck (Abdomen / Back / Chest / Shoulder)		Throat	
Leg (above ankle)		Foot (incl. ankle)		Toes	
Multiple				Other/specify	

FORMAT NO. : HSE-3 REV 0

(Sheet 3 of 5)

Accident type:

Struck against		Struck by		Fall from Elevation	
Fall on same level		caught in		caught under	
caught in between		Rubbed or abraded		Contact with (Electricity)	
Contact with (Temp./ extremes)		Contact with chemicals or oils		Vehicle accident	
Other/specify					

Name & Designation of person who provided First-Aid to the victim: _____

Name & Telephone number of Hospital where the victim was treated _____

Mode of transport used for transporting victim – Ambulance / Private car / Tempo / Truck / Others

How much time taken to shift the injured person to Hospital _____

In case of FATAL incident, indicate clearly the BOCW Registration No. of the victim/Company.....
...

Comments of Medical Practitioner, who treated / attended the victim/injured (attached / described here)_____

What actions are taken for investigation of the incident, please indicate clearly – (Video film / Photography / Measurements taken etc. .....)

Immediate cause (Please tick the right applicable) –

Hazardous methods or procedures inadequately guarded		Poor housekeeping		Inadequate or improper PPE	
Environmental hazards (excess noise/ space constraint/ inadequate ventilation		improper illumination/Moving on oval surface		Working on dangerous equipment	

FORMAT NO.: HSE-3 REV 0

(Sheet 4 of 5)

Failure to secure		Horse-play		Failure to use PPE	
Inattention to surroundings		Improper use of hands & body-parts		By-passing safety devices	
Unsafe mixing or placement of tools & tackles		Bypassing standard procedures		Failure in communication	
Operating without authority		Improper use of equipment or tools & tackles		drug or alcoholic influence	
excessive haste		Others(specify)			

Basic cause

Over confidence		Impulsiveness		over-exertion	
Faulty judgement or poor understanding		Failing to keep attention constantly		Nervousness & Fear	
Fatigue		Defective vision		Ill health or sickness	
Slow reaction		Others(specify)			

Root cause

Inadequate Engg.		Improper Design		Inadequate Planning & organization	
Inadequate knowledge		Inadequate skill		Inadequate training	
Inadequate supervision		Improper work procedure		Inadequate compliance with standard	
Substandard performance		Inadequate maintenance		Improper inspection	
Others(specify)					

Loss of man days and impact on site works, (if any) –

_____

Remarks from Contractor's Safety Officer/ Engineer –

Was the victim performing relevant tasks for which he was engaged /employed? Yes / No
Was the Supervisor present on work-site during the incident? Yes / No
Have the causes of incident rightly identified? Yes / No
Cause of Accident was _____

FORMAT NO. : HSE-3 REV 0

(Sheet 5 of 5)

Remedial measures recommended by **Safety Officer of Contractor** for avoiding similar incident in future

: .....

.....

.....

.....

.....

.....

.....

Intimation to local authorities (Dist. Collector / Local Police Station / ESI authority): Yes / No / NA.

If yes, to whom .....

Safety Officer
(Signature and Name)

Site Head / Resident Construction Manager
(Signature and Name)
Stamp of Contractor

To : Owner
: RCM/ Site-in-charge of EIL (3 copies)
Nodal Officer HO through RCM (In case of major accident)
Divisional Head (Constn.) through RCM
Project Manager EIL, through RCM

FORMAT NO. : HSE-4 REV 0

NEAR MISS INCIDENT/ DANGEROUS OCCURRENCE REPORTPROFORMA

(to be submitted within 24 hours)

Report No.: _____

Name of Site: _____ Date: _____

Name of work: _____ Contractor: _____

Incident reported by :

Date & Time of Incident :

Location :

Brief description of incident

Probable cause of incident

Suggested corrective action

Steps taken to avoid recurrence Yes ☐ No ☐

Safety Officer
(Signature and Name)
Stamp of Contractor

Site Head / Resident Construction Manager
(Signature and Name)

Note:

- **Near Miss:** Human injury escaped & no damage to property, equipmentor interruption to work.
- **Dangerous Occurrence**: Occurrences as mentioned below shall be considered as "Dangerous occurrences"

a. collapse or failure of lifting appliances or hoist or conveyors or other similar equipment for handling building or construction material or breakage or failure of rope, chain or loose gears; overturning of cranes used in building or other construction work; falling of objects from height;
b. collapse or subsidence of soil, any wall, floor, gallery, roof or any other part of any structure, platform, staging, scaffolding or any means of access including formwork;
c. collapse of transmission tower;
d. fire and explosion causing damage to property at Construction site.
e. spillage or leakage of hazardous substances and damage to their container;
f. Collapse, capsizing, toppling or collision of transport equipment;
g. Leakage or release of harmful toxic gases at the construction site.

To :Owner
:RCM/Site-in-charge EIL (3 copies)

Divisional Head (Const.) through RCM
Project Manager EIL, through RCM
} (Applicable for Dangerous Occurrence only)

FORMAT NO. : HSE-5 REV 0

MONTHLY HEALTH, SAFETY &ENVIRONMENTAL (HSE) REPORT

(To be submitted by each Contractor)

Actual work start Date: _____ For the Month of: _____

Project: _____ Report No: _____

Name of the Contractor: _____ Status as on: _____

Name of Work: _____ Job No : _____

(Contractor in consultation with EIL shall generate the reports through web basedpackage (www3.eil.co.in/eilhse)only.

ITEM		UPTO PREVIOUS MONTH	THIS MONTH	CUMULATIVE
1) Average number of Staff & Workmen (average daily headcount, not man days)				
2)Total Man-hours worked				
3) Number of site personnel undergone HSE Induction				
4) Number of HSE meetings organized at site				
5) Number of HSE awareness programmes conducted at site				
6) Number of Tool Box Talks conducted				
7) Number of Loss Time Injuries (LTI)	Fatalities			
	Other LTI			
8) Number of Non disabling injury (Non-LTI)				
9) Number of First Aid Cases				
10) Number of Near Miss Incidents				
11) Number of Dangerous Occurrences				
12) No. of unsafe acts/ practices detected				
13) No. of disciplinary actions taken against staff/ workmen				
14) Man-days lost due to injury				
15) LTI Free man-hours i.e. LTI free man-hours counted from the Last LTI (enter date: .....)				
16) Frequency Rate (No. of reportable LTI per 10lacs man-hours worked)				
17) Severity Rate (No. of man days lost due to LTI per 10lacs man-hours worked)				
18) No. of activities for which HIRAC Completed				
19) No. of incentives/ awards given				
20) No. of occasions on which penalty imposed by EIL/ Owner				
21) No. of Audits conducted				
22) No. of pending NCs in above Audits				
23) Compensation cases raised with Insurance				
24) Compensation cases resolved and paid to workmen				
25) No of Vehicular Accident cases				
26) No of fire/Explosion cases				

27) Whether workmen compensation policy taken			Yes		No
28) Whether workmen compensation policy is valid			Yes		No
29) Whether workmen registered under ESI Act, as applicable			Yes		No
30) Whether HIRAC Register prepared and updated			Yes		No
31) Whether Environment Aspect Impact Register prepared and updated			Yes		No
32) Whether Legal Register prepared and updated			Yes		No
Remarks, if any					

Date:

Prepared by Safety Officer Approved by Site Head / Resident Construction Manager

(Signature and Name)(Signature and Name)

To: -

- RCM EIL

FORMAT NO. : HSE-6 REV 1

PERMIT FOR WORKING AT HEIGHTS (ABOVE 2.0 METER)

(In duplicate to be issued daily for site and for office)

Permit No…….. Name of Main Contractor……
Name of work executing agency / sub agency / vendor:……..
Date…… Exact Location of work……
Nature of work ……..Duration of work (from) …… (to) ……..
Number of workers covered within this permit……
(*List enclosed with name & gate pass numbers.*)

Sl. No.	Items / Subjects	Status of compliance (Yes / No)	
1	Work areas / Equipment's inspected		
2	Work area cordoned off		
3	Adequate lighting is provided		
4	Precautions against public traffic taken		
5	Concerned persons in & around have been alerted & cautioned		
6	Hazards / risks involved in routine / non-routine task assessed and control measures have been implemented at specific task		
7	ELCB provided for electrical connection & found working		
8	Ladder safely attached / fixed		
9	Scaffoldings are checked and TAGs are found used correctly		
10	Working platforms are provided and are found sound /safe for use		
11	Safe access & egress arrangements (e.g. ladders, fall arresters, life-lines etc.) are satisfactorily incorporated		
12	a. Openings on platform / floors are effectively cordoned / covered		
	b. Safety Nets are provided wherever required		
13	Use of following safety gadgets by people working at area under this permit, is checked and found satisfactory - Safety helmet Safety harness (full body) with double lanyard Safety Shoes Safety gloves Safety goggles		
14	Housekeeping of work area found satisfactorily tidy / clean & clear		
15	Adequate measures have been taken for works being continued at the ground level, when simultaneous works are permitted overhead at that very location.		
16	Materials are not thrown from heights on to ground		
17	Medical examination of workers are made & found satisfactory		
18	Responsible job engineer / supervisor found physically present at work spot for overall administration of work as well as safety of people.		

Above items have been checked & compliance has been found in place. Hence work is permitted to start / continue at the above-mentioned location. Work shall not start till identified lapses are rectified.

Additional Precautions, if any ……
……

Work Permit Receiver Verification By Work Permit issuer
Contractor Job Supervisor Contractor Safety Officer Contractor Engineer/RCM

AT THE END OF THE DAY/WORK:
All works at height are completed & workmen have returned safely from work location at (time)…….. (date)……

(Sig. Contractor Engineer)

FORMAT NO. : HSE-7 REV 1

CONFINED SPACE ENTRY PERMIT

Project site _____ Sr. No. _____

Name of the work _____ Date _____

Name of Contractor _____ Nature of work _____

Exact location of work _____

Safety Requirements POSITIVE ISOLATION OF THE VESSEL IS MANDATORY

(A) Has the equipment been ?

Y	NR		Y	NR		Y	NR	
☐	☐	Isolated from power/steam/air	☐	☐	water flushed &/or steamed	☐	☐	radiation sources removed
☐	☐	isolated from liquid or gases	☐	☐	Man ways open & ventilated	☐	☐	proper lighting provided
☐	☐	depressurized &/or drained	☐	☐	cont. inert gas flow arranged	☐	☐	
☐	☐	blanked/ blinded/ disconnected	☐	☐	adequately cooled	☐	☐	

(B) Expected Residual Hazards

☐	☐	lack of O_2	☐	☐	combustible gas/ liquid	☐	☐	H_2S / toxic gases
☐	☐	corrosive chemicals	☐	☐	pyrophoric iron / scales	☐	☐	electricity / static
☐	☐	heat/ steam / frost	☐	☐	high humidity	☐	☐	ionizing radiation
☐	☐		☐	☐		☐	☐	

(C) Protection Measures

☐	☐	gloves	☐	☐	ear plug / muff	☐	☐	goggles / face shield
☐	☐	protective clothing	☐	☐	dust / gas / air line mask	☐	☐	personal gas alarm
☐	☐	grounded air duct/blower /AC	☐	☐	attendant with SCBA/air mask	☐	☐	rescue equipment/team
☐	☐	Fire fighting arrangements	☐	☐	safety harness & lifeline	☐	☐	communication equipment
☐	☐		☐	☐		☐	☐	

Authorization / Renewal (It is safe to enter the confined space)

	No. of persons allowed	Name of persons allowed	Signature			Time		Signature
			Work Permit Receiver(Contractor Supervisor)	Verification by Contractor Safety officer	Work permit issuer Contractor Engineer/RCM	From	To	Workman

Permit Closure :

(A) Entry ☐ was closed ☐ stopped ☐ will continue on ...

(B) ☐ Site left in a safe condition ☐ Housekeeping done

(C) Multi lock ☐ removed ☐ key transferred

☐ Ensured all men have come out ☐ Man-ways barricaded

Remarks, if any:

FORMAT NO. : HSE-8 REV 0

RADIATION WORK PERMIT

Project :
Name of the work :
Name of site contractor :

Sr. No. :
Date :
Job No. :

Location of work :

Source strength :

Cordoned distance (m) :

Name of Radiography agency :

Approved by Owner/EIL ☐

No. of workers engaged :
(*List enclosed with name & gate pass numbers.*)

The following items have been checked &compliance shall be ensured during currency of the permit:

S. No.	Item description	Done
	Safety regulations as per BARC/AERB ensured while source in use/in transit & during storage	
	Area cordoned off / safe working platform provided	
	Lighting arrangements for working during nights ensured	
	Warning signs/ flash lights installed	
	Cold work permit taken (if applicable)	
	PPEs like film badges, dosimeters used	

Additional precautions, if any _____

(Radiography Agency's BARC/AERB authorized Supervisor)

Permission is granted.

Permit is valid from _____ AM/PM _____ Date to _____ AM/PM _____ Date

(Signature of permit issuing authority-RCM of contractor)
Name : Designation: Date:

Permit renewal:

Permit extended up to		Additional precautions required, if any	Sign of issuing authority with date (of site contractor)	
Date	Time			

Work completed/ stopped/ area cleared at _____ Hrs of Date _____
(Sign. of permit issuing authority)
Name& Signature of site contractor:

FORMAT NO. : HSE-9 REV 1

DEMOLISHING/DISMANTLING WORK PERMIT

Project :
Name of the work :
Name of contractor :

Sr.No. :
Date :
Job No. :

Name of sub-contractor :

No. of workers to be engaged:
(List enclosed with name & gate pass numbers.)

Line No./ Equipment No./ Structure to be dismantled :

Location details of dismantling/ demolition with sketch : (clearly indicate the area)

The following items have been checked &compliance shall be ensured during currency of the permit:

S. No.	Item description	Done	Not Applicable
	Services like power, gas supply, water, etc. disconnected	☐	☐
	Dismantling/ Demolishing method reviewed & approved	☐	☐
	Usage of appropriate PPEs ensured	☐	☐
	Precautions taken for neighboring structures	☐	☐
	First-Aid arrangements made	☐	☐
	Fire fighting arrangements ensured	☐	☐
	Precautions taken for blasting	☐	☐

Work Permit Receiver
(Contractor's Supervisor/Engineer)

Verification by Contractor
(Contractor's Safety Officer)

Permission is granted.

(Work Permit issuer-Client)

Name :
Date :

Completion report:

Dismantling/ Demolishing is completed on _____ Date at _____ Hrs.

Materials/ debris transported to identified location ☐ Tagging completed (as applicable) ☐

Services like power, gas supply, water, etc. restored ☐

(Permit issuing authority-Client)

CONTRACTOR's NAME

FORMAT NO. : HSE-10 REV 0

DAILY SAFETY CHECKLIST

(To make use of before start of day's work)

Project :
Name of the work :
Name of contractor :

Sr.No. :
Date :
Job No. :

Description of Job decided to perform : -

- **Use of PPE / Safety Gadgets**

Sl. No	PPEs	Compliance (Yes / No)	Sl. No	PPEs	Compliance (Yes / No)
1	Safety Helmets		6	Face Shield	
2	Safety Shoes		7	Full body harness	
3	Hand Gloves		8	Fall Arrest System	
4	Dust Musk		9	Safety net	
5	Safety Goggles		10	Horizontal life-line made of steel wire, (dia not less than 8.0 mm.)	

(Serial No. 1 & 2 are compulsory for everyone. Specify & ensure use of other safety gadgets as required for the job)

- **Identify following important unsafe conditions: -**

Sl. No	Conditions	Yes / No
1	Access to work site / emergency escape clear	
2	Soil / Loose earth kept away from excavated pit / slope / ladder provided	
3	Electrical wire / welding lead lying entangled on ground / welding m/c. booth accessible	
4	Elevated work platform / open ends are protected	
5	Ground area cordoned off before lifting works or erection at height / ground area checked & cordoned-off before start of height works	
6	Structural members / erected pipes / wooden boards/pieces etc. are safely anchored at heights and are not likely to fall down on people when working beneath	
7	Ladders tied-up on tall steel structures, long before are removed to get rid of their use	
8	Any Other	

- **Indicate actions taken, if status of any of the above items is found "No"**
  .....
  .....
- **Specific Safety guidelines / precautions, if any** (communicated thro' TBT)
  .....
  .....
- **Above conditions and PPE compliances are checked by undersigned and correct status are indicated after verification**

Prepared by
Contractor Site Engineer

Verification By
Contractor Safety Officer

FORMAT NO. : HSE-11 REV 0

(Sheet 1 of 2)

HOUSEKEEPING ASSESSMENT& COMPLIANCE

Project :
Name of the work :
Name of contractor :
Name of contractor : Fortnightly

Sr.No. :
Date :
Job No. :

Sl. No.	Subjects of Review	Satisfactory/ Yes	Non satisfactory/No	Remarks	Action
1.	Cleanliness at the Main entry / access of site				
2.	Ground condition / floor areas free from water-logging / oil spillage				
3.	Ground & elevated floors free from rubbish / wastes / accumulated debris / scraps.				
4.	Manholes / openings are covered / fenced				
5.	Trenches are barricaded / walkways are in place				
6.	Drains are cleaned / not choked / not occupied by dumped materials				
7.	Sufficient CAUTION boards / instructions displayed				
8.	Construction machinery are maintained & parked in orderly manner.				
9.	Movement of site people are not obstructed because of dumping / storing of construction materials				
10.	Access / egress to Electrical Distribution Boards / Panels clear from wires / cables / earth-strips etc.				
11.	Electrical panel rooms / sheds / MCC / Control rooms / Substations etc. are clean & tidy and not used for storing dress / clothes, tiffin-box or bicycles.				
12.	Passage behind Elec. panels are free for access				
13.	Fire extinguishers / fire-buckets are accessible without any difficulty.				
14.	Stair-steps, platforms & landings are clear & tidy				
15.	Sheds / rooms & work areas have got sufficient illumination as well as ventilation				
16.	Cables / Wires / welding leads are routed / hanged appropriately & are not creating unsafe condition.				
17.	Stacking / storing of insulation materials or their packing.				
18.	Removal or cleanliness of left-over sand, concrete, brick-bats, insulation-materials, excess earth, wastes etc.				
19.	Storing / stacking of sand, metal chips, re-bars, steel pipes, valves, fittings etc.				
20.	One escape route at ground & minimum two escape routes at elevation available,				

FORMAT NO. : HSE-11 REV 0

(Sheet 2 of 2)

Sl. No.	Subjects of Review	Satisfactory/ Yes	Non satisfactory/No	Remarks	Action
21.	Captions / Posters / Slogans on various safety instructions are displayed legibly in local language				
22.	Cable trenches are water-free or regular arrangement for taking out accumulated water exists.				
23.	Windows of rooms / offices are regularly cleaned				
24.	Facilities for cycle sheds, drinking water, washing, rest-rooms etc. are maintained in tidy manner.				
25.	Toilet, Urinals, Canteen / kitchen / pantry etc. are maintained & free from obnoxious smell.				
26.	Construction tools / tackles are stored systematically - the items are tagged / tested / certified by competent third party.				
27.	Sufficient numbers of Dust-bins / Waste-bins found at site and are regularly emptied.				

Additional remarks, if any -

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Inspected by
Contractor Engineer

Verification By
Contractor Safety Officer

FORMAT NO. : HSE-12 REV 0

INSPECTION OF TEMPORARY ELECTRICAL BOOTH / INSTALLATION

Project :
Name of the work :
Name of contractor :
Sub Station No:/Booth No

Sr.No. :
Date :
Job No. :
Location:

SL NO	SUBJECTS	OBSERVATION (YES /NO)	ACTION TAKEN
1	Switchboards installed properly are in order and protected from rain & water-logging.		
2	Adequate illumination provided for switchboard operation during night hours & the lamps are protected from direct human contact.		
3	Voltage ratings, DANGER signs, Shock-Treatment-Chart displayed in the installation / booth		
4	Fire extinguisher (DCP or CO_2) & Sand Bucket kept in close vicinity of Switchboards		
5	Valid License & Competent Electrician / Wireman available & name/ license no. displayed at booth / installation.		
6	General housekeeping in & around booth / installation found in order.		
7	Cable-route-markers for U/G cables provided.		
8	Monthly inspection report of Electrical hand tools available in booth / installation.		
9	Electrical Panel door to be in closed condition and Insulated Mat to be provided in front of panel.		
10	Rubber hand gloves available/ used by Electricians		
11	Availability of CAUTION boards for shutdown & / or repairing works.		
12	All incoming & outgoing feeders have proper MCCB / HRC fuses / Switches.		
13	Switchboards "earthed" at two distinctly isolated locations.		
14	Switchboards have adequate operating space at the front face & at the rear face too.		
15	All connections provided through 30mA ELCB.		
16	Testing records of all ELCBs available at site		
17	Only industrial type plugs & sockets are used.		
18	Temporary connections are 3-core double insulated & free from cuts & joints and 3rd core is earthed at both ends		
19	Socket boards are properly mounted on stand & protected from water ingress.		
20	Electrical equipments operating above 250V have two earthing / double earthing.		
21	All incoming / outgoing cables are properly glanded& terminated with "lugs".		
22	Switch-boards are of industrial variety / type.		
23	Sketch for installation / connection (SLD) made & pasted& other safety labels/display boards		
24	Labeling of incoming / outgoing feeders made.		
25	All hand lamps are protected from direct contact.		
26	All electrical cable / joints are in safe condition		

Inspected by
Contractor Engineer

Verification By
Contractor Safety Officer

FORMAT NO. : HSE-13 REV 0

(Sheet 1 of 2)

INSPECTION FOR SCAFFOLDING

Project :
Name of the work :
Name of contractor :

Sr.No. :
Date :
Job No. :

Sl. No	Description	Yes	No	N.A.	Actions taken
1	Whether work permit is obtained to take up work at height above 1.5 Mts?				
2	Whether atmospheric condition is "stormy" or "raining" and works at heights have been permitted?				
3	Whether steel pipes scaffoldings are used for units /off-site areas?				
4	Whether scaffolding has been erected on rigid/firm/leveled surfaces / ground? Whether "foot-seals" or "base-plates" are used beneath the up-rights (vertical steel pipes)				
5	Whether scaffold construction is as per IS specification with toe-board and hand-rails (top-rail as well as mid-rail)?				
6	Whether distance between two successive up-rights are less than 2.5 Mts (height of scaffold & load carrying capacity governs the distance between two uprights)				
7	Whether all uprights are extended at least 900 mm above the top most working platform (to enable fitting of handrails)?				
8	Whether vertical distance of two successive ledgers is satisfactory? *(varying between 1.3 Mts. To 2.1 Mts)*				
9	Whether the peripheral areas of working at height are cordoned-off? (for avoiding accident to people arising out of dropped / deflected materials)				
10	Whether platform is provided? Is it safely approachable?				
11	Whether end of scaffold platform / board are extended beyond transoms? (125mm to 150 mm)				
12	Whether CE / IS approved quality and worthy conditioned full-body safety harness (with double lanyard & karabiners) are used while working at heights?				
13	Whether life-line of safety harness is anchored to an independent secured support capable of withstanding load of a falling person?				
14	Whether the area around the scaffold is cordoned off to prohibit the entry of unauthorized person / vehicle?				
15	Whether clamps used are of good condition, of adequate strength and free from defects?				
16	Whether ladder is placed at secured and leveled surface?				
17	Whether water-pass and oil-spills are avoided around the scaffold structure?				
18	Whether ladder is extended 1.5mts. above the landing point at height?				
19	Whether more than one access/egress provided to the scaffold?				
20	Whether ladder used are of adequate length and overlapping of short ladders avoided?				
21	Whether metallic ladders are placed much away from near-by electrical transmission line?				
22	Whether rungs of ladder are inspected and found in good order?				
23	Whether fall-arresters provided on both the access/egress routes?				
24	Whether diagonal (cross) bracings are provided at regular interval on the scaffold?				
25	Whether working platform on the scaffold has been made free from "jolt" or "gap"?				
26	Whether tools or materials are removed after completion of the day's job at heights?				
27	Whether a valid Permit for Work (PFW) is obtained before taking up work over asbestos or fragile roof?				
28	Whether sufficient precaution is taken while working on fragile roof?				

FORMAT NO. : HSE-13 REV 0

(Sheet 2 of 2)

Sl. No	Description	Yes	No	N. A	Actions taken
29	Whether provision is made to arrange duck ladder, crawling board for working on fragile roof?				
30	Whether scaffold has been inspected by qualified civil engineers prior to their use?				
31	Whether the scaffolding has been designed for the load to be borne by the same?				
32	Whether the erection and dismantling of the scaffolding is being done by trained persons and under adequate supervision?				
33	Whether safety net with proper working arrangement and life-line has been provided?				
34	Whether TAGS (Green for acceptable and Red for incomplete/unsafe scaffolds) are used on scaffolds?				
35	Whether sufficient illumination is provided in and around the scaffold and access?				
36	Whether emergency rescue / response arrangements are made in place				

Inspected by
Contractor Engineer

Verification By
Contractor Safety Officer

FORMAT NO. : HSE-14 REV 1

(sheet 1 of 2)

PERMIT FOR ERECTION / MODIFICATION & DISMANTLING OFSCAFFOLDING

Project :
Name of the work :
Name of contractor :
Nature of activities :

Sr.No. :
Date :
Job No. :
Duration: From.....To.....

SL. No.	SUBJECTS / ITEMS	DONE	NOT DONE	REMARKS
1	Specific task of Erection / Modification / Dismantling of scaffolds, identified & TAGGED accordingly (before as well as after carrying-out jobs).			
2	People engaged in doing the job are identified & are certified by Job Engineer of Main Contractor as experienced / trained.			Names to be noted
3	Concerned persons are alerted by the Job Engineer of Main Contractor in connection with possible hazards & what the workmen MUST do / MUST not do.			
4	Verification by Job Engineer of Main Contractor made for confirming that all persons permitted to carry-out the jobs are making use of Helmet, Safety Shoes, Goggles, Gloves & Double lanyard safety harness and other relevant PPEs.			
5	Area of work is effectively cordoned-off / barricaded / illuminated.			
6	For taking-up / lowering down Scaffolding members / clamps / couplings etc. appropriate ropes / pulleys/ chains etc. have been arranged for use (not to throw any item) & the same have been verified as "fit for purpose".			
7	Items / members of scaffold, being lowered are removed from the area & stacked correctly.			
8	Ropes, chains, pulley blocks etc. being used for lifting or lowering scaffold items, are inspected by the Job Engineer & their certifications as well as physical conditions have been found O.K. before signing this PERMIT.			
9	Safety Net / Life-line / Fall Arresters etc. are arranged in position and Job Engineer has found working conditions favorable for activities to start.			
10	Scaffold erection or dismantling tasks are being supervised by Experienced Engineer / Competent person.			
11	Only competent & experienced people have been selected / engaged in Scaffolding erection, modification or dismantling tasks.			
12	Adequate & effective actions for traffic and movement of people around the cordoned-off area taken to avoid inadvertent incident			
13	Working platforms are protected with handrails & toe-boards.			
14	Access & Exit (for reach & escape) are safe for use by people.			
15	Tools, tackles to be used for above jobs are verified by job Engineers of Main contractor as genuinely good and tied-up at height (to prevent their fall).			
16	Site important Telephone Nos. are made known to everyone			
17	SOP (Safe Operating Procedure) for the specific task is made & followed too.			
18	Emergency vehicle has been arranged at work locations.			

- This permit for work shall be available at specific work location all the time.
- After completion of work, permit shall be returned to safety cell of main contractor, without fail.
- This Permit shall be issued maximum upto (Monday to Sunday).
- Additional Precautions, if any

  .....

- **ACCORD OF PERMISSION** (to be ticked) - **YES** ( )/ NO ( )

  Work Permit Receiver Verification By Work Permit issuer Contractor Job Supervisor
  Contractor Safety Officer Contractor Engineer/RCM

FORMAT NO. : HSE-14 REV 1

(sheet 2of 2)

Everyday Site working conditions & performance of workmen shall be assessed / checked by Contractor Site Engr. and Safety Officer shall verify the same.

	Name / Sign.	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
Site Engr.								
Safety Off.								

FORMAT NO. : HSE-15 REV 1

PERMIT FOR HEAVY LIFT/CRITICAL ERECTION

Project :
Name of the work :
Name of contractor :
Nature of activities :
Location of work :
Equipment/Structure to be erected:

Sr. No. :
Date :
Job No. :
Duration: From.....To.....
Name /Type of crane :
Wt. of equipment/ structure to be erected

SL. NO.	Description of Item	COMPLIANCE STATUS			Remarks
		Yes	No	Not applicable	
1)	Is the crane type suitable for lift or as per erection procedure?				
2)	Is the crane have the correct number of counterweights fitted?				
3)	Availability of Load Certification of crane from authorized agency.				
4)	Is the load chart of crane available in carne cabin/or with Crane operator?				
5)	Is the device to check the Wind speed in crane is working? Is the safety features in crane are working?				
6)	Availability of Load certification of slings and other accessories from authorized agency				
7)	Availability of Licensee/certificate for crane operator from authorized agency.				
8)	Availability of approved HIRAC for the subject activities.				
9)	Availability of approved erection/rigging procedures.				
10)	Availability of temporary gratings/ platforms for critical lifting(as applicable)				
11)	Tool Box conducted before erection?				
12)	Has the area been cordoned off?				
13)	Are the authorized persons during erection are identified?				
14)	Does each person identified for erection understand their roles and responsibilities?				
15)	Is the ground on which crane will rest or outrigger support are correct?				
16)	Is hard stand requirement (if any) complied?				
17)	Is the communication system (viz walkie-talkies, etc. are working properly?				
18)	If more than one crane is lifting the load, is an Intermediate rigger will supervise the lift?				
19)	If there is other obstruction within the operating radius of the crane, have correct precautions been taken to prevent collision?				
20)	All the persons are wearing the requisite PPE?				

Work Permit Receiver Verification By Work Permit issuer Contractor Job Supervisor
Contractor Safety Officer Contractor Engineer/RCM

FORMAT NO. : HSE-16 REV 1

PERMIT FOR ENERGY ISOLATION & DE-ISOLATION

Project :
Name of the work :
Name of contractor :

Sr.No. :
Date :
Job No. :

ENERGY ISOLATION PERMIT

- Clearance required from:.....Hrs .....Date To .....Hrs ....Date
- Name of equipment/ energy source etc. .....
- Nature of job to be done: .....
- Area.....Location:.....

PERMIT VALIDATION	PERFORMING AUTHORITY
I hereby authorize the .....personnel(performer) to isolate the above equipment/energy source from all sources of power and handover the equipment/energy source for maintenance/repair. Issuing authority Client/Contractor RCM (as applicable) Signature: Date: Name:	The work and precautions will be carried out under my overall responsibility.(Testing/execution engineer) Signature: Date: Name:

SAFETY PRECAUTIONS FOR CLEARANCE	NORMALISING AFTER CLEARANCE
1. Notify workers of intent to de- energize ☐ 2. Obtain lock, tag or locking/tagging devices ☐ 3. Shut down, de-energize, dissipate any residual energies. ☐ 4. Apply lock ,tag and locking and/or tagging devices ☐ 5. *Any other job specific precautions ☐ 6. Verify effectiveness of lockout by attempting to restart. ☐ 7. Proper PPE is ensured ☐ I certify that the energy source mentioned above is isolated from all sources and is safe to start the work. Tag No:..... Lock No:..... Issuing authority Client/Contractor RCM (as applicable) Signature: Date: Name: **(*to be included by contractor in consultation with issuing authority)**	1. Notify workers of intent to re- energize ☐ 2. Conduct visual inspection to confirm that the danger zone is clear of workers ☐ 3. Conduct visual inspection to confirm that tools ,equipment's danger zone is clear of workers ☐ 4. Reposition the safety devices(interlocks, valves, guards, covers ,sensors, as applicable, etc.) ☐ 5. *Any other job specific normalizing details ☐ 6. Remove lock, tag and locking and/or tagging devices. ☐ 7. Re-energize. ☐ 8. Confirm system is operating properly& safely I certify that the energy source mentioned above is isolated from all sources and is safe to start the work. Tag No:..... Lock No:..... Issuing authority Client/Contractor RCM (as applicable) Signature: Date: Name: **(*to be included by contractor in consultation with issuing authority)**

ENERGY DE-ISOLATION PERMIT

PERMIT VALIDATION	PERFORMING AUTHORITY
I hereby authorize the .....personnel(performer) to de- isolate the above equipment/energy source from all sources of power and handover the equipment/energy source for normal operation.. Issuing authority Client/Contractor RCM (as applicable) Signature: Date: Name:	I hereby certify that the equipment/energy source mentioned above has been de-isolated and is ready for normal operation.(Testing/execution engineer) Signature: Date: Name: Countersigned by Issuing authority

FORMAT NO. : HSE-17 REV 1

PERMIT FOR EXCAVATION (depth 2m and above)

(Sheet 1of 2)

Project :
Name of the work :
Name of contractor :
Job Description :
Size of excavation :

Sr.No. :
Date :
Job No. :
Location:

SL. NO.	Description of Item	COMPLIANCE STATUS			Remarks
		Yes	No	Not applicable	
1)	Suitable and sufficient risk assessments and method statements has been carried to ensure that the work shall be undertaken in accordance with specification and standard.				
2)	Are plans/details of underground services available and the same has been reviewed?				
3)	Has survey done to locate the services/obstacles etc.				
4)	Has the live services (electrical, water line, air line, telephone line, etc)has been disabled for carrying out the job.				
5)	Is adequate barriers/fences to protect the excavation are in place?				
6)	Is Adequate warning signs are in place?				
7)	Is Assessment of ground conditions done and remedial action(if any) taken?				
8)	Safe access / egress (e.g. ramp / steps / ladders etc.) provided for site workmen & supervisors.				
9)	Is the excavation work being undertaken in proximity of structure, etc. ?If Yes, it's effect is considered?				
10)	Availability of competent person for supervising the excavation work?				
11)	Adequate safe arrangement to prevent collapse of edges (e.g. shoring / strutting / benching / sloping etc.) made at site.				
12)	Hard barricades (at least 1.0M away from edge & for excavation near site access roads) with warning signs/caution boards are provided				
13)	Accumulation / passage-ways of water at periphery of excavation / trench stopped/ restricted.				
14)	Is the equipment being used for excavation has been checked for adequacy and is in good working condition having all the safety features?				
15)	Age & fitness of workmen ensured by medical test before engagement in job ?				
16)	Arrangement of Monitoring of possible oxygen deficiency or obnoxious gases done & action taken?				

PERMIT GRANTED - Yes / No

(*List enclosed with name & gate pass numbers.*)

Name & Signature of Site Engr.

Name & Signature of Area – In charge/RCM of Contractor (Receiver)

Contractor (Issuer)

Verification by Contractor Safety Officer

FORMAT NO. : HSE-17 REV 1

PERMIT FOR EXCAVATION

(Sheet 2of 2)

NOTES: -

1. Slopes or benches for excavation beyond 2.0M depth shall be designed & approved by Contractor's site head.
2. Excavated earth to be kept at least 1.5M away from edges
3. Safety helmets, Safety shoes or gum-boots, gloves, goggles, Face shield, Safety Harness shall be essential PPEs.
4. Permit shall be made in **duplicate** and original shall be available at site of work.
5. Permit shall be issued for maximum **one week** only (Monday to Sunday)
6. After completion of works, permit shall be closed & preserved for record purpose

GRANT OF PERMIT AND EXTENSIONS

Sl. No.	Validity period From ____To ____	Working Time From _____To _____	Receiver (site Engr. of Main Contractor)	Issuer(Area In charge/RCM of Main Contractor)	Review by EIL / Owner (Remarks with date
1.					
2.					
3.					
4.					
5.					
6.					
7.					

Additional safety instructions if any: -

1.

2.

3.

FORMAT NO. : HSE-18 REV 0 **(Sheet 1of 2)**

IDENTIFICATION OF ENVIRONMENTAL ASPECTS, IMPACT ASSESSMENT AND CONTROL MEASURES

S.No	Activity	Environmental Aspect	N/A/E	Environment Impact	Control Measures	Consequences						Risk Level	Significant	Gaps/ Recommendations
						A	B	C	D	E	F	G	Yes/No	

(Sheet 2 of 2)

INITIAL ENVIRONMENT REVIEW TECHNIQUE

Environmental Impacts	AP = Air Pollution	WP = Water Pollution	LC = Land Contamination	DNR = Depletion of Natural Resources	NP = Noise Pollution

Scale	**Quantity (A)**	**Occurrence (B)**	**Severity of Impact (C)**	**Detection (D)**	**Control (E)**	**Legal and other requirements (F)**
1	Negligible	Very Rare	Negligible visual impact	Immediately	Available & effective at place	In compliance or not applicable
2	Low	Once a month or less	Causes Discomfort or Nuisance	Within 1 hour	Has in-built Secondary control	
3	Moderate	Once a day	Resource Depletion	Within 8 hours	Needs human Intervention	
4	High	Several times a Day	Affects Aquatic Life, flora, fauna or global issue	Within 24 hours	Mechanism in place but not reliable	
5	Excessive	Continuous	Human health effect	More than 24 hours	Absent or no effective control	Not in compliance

Risk Level - G : A x B x C x D x Ex F

Aspects with score of **100 and above** are considered as significant.
Also, Irrespective of the score, all legal noncompliance's to be considered as significant

Condition	
N	NORMAL
A	ABNORMAL
E	EMERGENCY

FORMAT NO. : HSE-19 REV 0 HIRAC

Risk Identification						Desired Controls & Existing Gaps, If Any		Risk Assessment				Recommended Control Actions To Reduce The Risk Level	Action By	Remarks
SN	Activity	Activity Type (R/NR)	Hazards	Condition(N/AN/E)	Associated Risk	Desired Control Measures	Gaps If Any	Probability(P)	Impact (I)	Risk R= P*I	Risk Classification			

Likelihood – Possibility of occurrence of risks based on present gaps (technological / operational / competence / measurement and monitoring);

UL: Unlikely, **L:** Likely, **VL:** Very Likely, **FR:** Frequent, **C**: Continuous

Impact –

SI: Slight Injury, **MI:** Minor Injury, **MJ:** Major Injury, **SF:** Single Fatality, **MF:** Multiple Fatalities

Level of consequence – Refer Guidance criteria for this i.e. possible degree of damage;

Condition- N: Normal, **AN**: Abnormal, **E**-Emergency

Activity Type: R- Routine, NR- Non Routine

RISK –

L: Low Risk, **M:** Moderate Risk, **H:** High Risk

FORMAT NO.: **HSE-20 REV 0**

Inspection of Tower Crane

Name of Contractor: **Project:**

Name of Work: **Job No:**

Vehicle Identification/Registration No: **Date:**

Sr. No.	Description	Observation	Remarks & Suggestions
1	Serial number plate &SWL marking		
2	Valid TPI Certificate		
3	Valid Insurance		
4	Safe access and egress are provided to the crane operator.		
5	Front glass of Operator cabin		
6	Operator crane cabin is provided with a locking mechanism so as to prevent unauthorised entry.		
7	A safety bar is fitted across the operator's cabin window where there is likelihood of the operator falling through it.		
8	Manufacturer Operating Manual and Maintenance Manual are made available.		
9	An updated Operation and Maintenance log book is available in the operator cabin.		
10	All mounting bolts are in good condition.		
11	Load chart provided		
12	SLI available		
13	Crane hooks have got smooth surface and no dent		
14	Hook-latch / Dog-clamp in hook is effective		
15	Over hoist limit switch		
16	Double body earthing of Tower Crane		
17	Jib angle indicator is provided (For Luffing Jib Tower Crane).		
18	Emergency stop button, which will terminate the operation of the crane engine, is installed in the operator cabin and correctly identified.		
19	Effective braking mechanisms for Hoisting, Derricking, Slewing, Trolley Travelling maintained:		
20	Trolley Travelling limiter to prevent over-travelling of trolley is functional.		
21	Limit switches to prevent over-derricking and over-lowering of jib (For Luffing Jib Tower Crane) is functional.		
22	Slewing limiter to restrict slewing of crane is functional.		
23	Over load Limiter to prevent overloading of crane is functional.		
24	Load Moment Limiter to prevent over-turning moment is functional.		
25	Anti-collision devices are tested to stop the tower crane's operation such that the crane-to-crane interference must be maintained at not less than 3 m.		
26	Condition of boom		
27	Counter weight placement and pins		
28	Winches, pulleys and wire ropes are in good working condition.		
29	Colour coding		
30	Leakage in hydraulic cylinder		

31	Fire Extinguisher		
32	Tower crane is adequately grounded or protected against lightning.		
33	Wind anemometer is installed and is in good working condition.		
34	Aviation lamp is functional (Reqd. for 30mt and above)		
35	Pre Medical Check-up& Periodic Medical check-up (every 6 months) including vision test for Operator		
36	Safety Induction for Operator		
37	Others		

Signature & Name of Operator:

Signature and name of Job Engineer

Signature & Name of Contractor's Safety Officer

FORMAT NO. : HSE-21 REV 0

Crane Inspection Checklist

Name of Contractor: **Project:**

Name of Work: **Job No:**

Vehicle Identification/Registration No: **Date:**

Sr. No.	Description	Observation	Remarks & Suggestions
1	Crane hooks have got smooth surface and no dent		
2	Hook-latch / Dog-clamp in hook is effective		
3	Over hoist limit switch		
4	Over Load Indicator		
5	Over Boom limit switch		
6	Boom angle indicator		
7	Colour coding		
8	Condition of boom		
9	Condition of wire rope		
10	Rope drum / sheaves are in good working condition		
11	Swing break & lock		
12	Swing Alarm		
13	Over hoist break & lock		
14	Boom break & lock (For Telescopic Boom)		
15	Leakage in hydraulic cylinder		
16	Condition of Outrigger (For Tyre Mounted Crane)		
17	Outrigger fully extended Marking (For Tyre Mounted Crane)		
18	Condition of Tyre (For Tyre Mounted Crane)		
19	Wheel chokes are present and are used whenever required (For Tyre mounted)		
20	Battery & lamps		
21	Moving & rotating parts guarded		
22	Load chart provided		
23	Reverse horn (For Tyre Mounted Crane)		
24	Body Condition of crane		
25	Front glass of Operator cabin		
26	Both side Mirror		
27	Number Plate (For Tyre Mounted Crane)		
28	Fire Extinguisher		
29	Horn		
30	Windshield and wipers		
31	Working of light & Indicator		
32	SLI		
33	Spark Arrestor(For Running Refinery/ Petrochemical/Chemical Plant)		

34	Foot-steps and hand-holds are in good working condition for exit /enter in to cabin		
35	TPI Certificate		
36	RC Document (For Tyre Mounted Crane)		
37	Fitness Certificate of Vehicle by authority		
38	Insurance		
39	PUC		
40	HMV License for Operator		
41	Pre Medical Check-up& Periodic Medical check-up (every 6 months) including vision test for Operator		
42	Safety Induction for Operator		
43	Others		

Signature & Name of Operator:

Signature & Name of Contractor's Concern Engineer

Signature & Name of Contractor's Safety Officer

FORMAT NO. : HSE-22 REV 0

Hydraulic Mobile Crane- Inspection Checklist

Name of Contractor: **Project:**

Name of Work: **Job No:**

Vehicle Identification/Registration No: **Date:**

Sr. No.	Description	Observation	Remarks & Suggestions
1	Identification number of Hydraulic Mobile crane boldly scribed in front and rear end of machine		
2	Operator has got adequate document in support of his competency (i.e. HMV driving license, knowledge & training)		
3	Marking of SWL on hook position is clearly visible		
4	Test & examination of Hydraulic Mobile crane by statutory / competent authority is carried out & document is valid		
5	Colour Coding		
6	RC Document		
7	Fitness Certificate of Vehicle by authority		
8	Valid Insurance		
9	Valid PUC		
10	Pre Medical Check-up& Periodic Medical check-up (every 6 months) including vision test for Operator		
11	Safety Induction for Operator		
12	Crane hooks have got smooth surface and no dent		
13	Hook-latch / Dog-clamp in hook is effective		
14	Over hoist limit switch		
15	Over Load Indicator		
16	SLI		
17	Condition of boom		
18	Condition of wire rope		
19	Rope drum / sheaves are in good working condition		
20	Leakage in hydraulic cylinder		
21	Tyre condition		

22	Battery		
23	Moving & rotating parts guarded		
24	Break		
25	Parking Break		
26	Front horn		
27	Reverse horn		
28	Hydraulic Mobile Crane cabin body and frame of machine is in good order		
29	Both side Mirror		
30	Fire Extinguisher		
31	Front glass pane of the Hydraulic Mobile operator's cabin is clean & clear (i.e. not cracked / damaged / broken)		
32	Windshield and wipers condition		
33	Working of front & back lights, turn Indicators, parking lights & fog lamps		
34	Spark Arrestor(For Running Refinery/ Petrochemical/Chemical Plant)		
35	Wheel chokes are present and are used whenever required		
36	Foot-steps and hand-holds are in good working condition for exit /enter in to cabin		
37	Others		

Signature & Name of Operator

Signature & Name of Contractor's Concern Engineer

Signature & Name of Contractor's Safety Officer

FORMAT NO. : HSE-23 REV 0

Hydraulic Rig Inspection Checklist

Name of Contractor: **Project:**

Name of Work: **Job No:**

Vehicle Identification/Registration No: **Date:**

Sr. No.	Description	Observation	Remarks & Suggestions
1	Control panel is clean & all buttons/switches are clearly visible (no paint over spray, etc.)		
2	All switch & mechanical guards are in good condition and properly installed		
3	All Safety Indicator lights work		
4	Drive controls function properly & accurately labelled (up, down, right, left, forward, back)		
5	Motion alarms are functional		
6	Safety decals are in place and readable		
7	Any defects such as cracked welds, fuel leaks, hydraulic leaks, damaged control cables or wire harness, etc.		
8	Braking devices are operating properly		
9	Winches, pulleys and wire ropes are in good working condition.		
10	Function of interlocks and limit switch		
11	The manufacturer's operations manual (in all languages of the operators)		
12	Oil level, Hydraulic Oil Level, Fuel Level, Coolant Level		
13	Battery Charge		
14	Outriggers in place or functioning. Associated alarms working		
15	Moving & rotating parts guarded		

16	Load chart provided		
17	Fire Extinguisher		
18	Spark Arrestor, if operated by using fuel(For Running Refinery/ Petrochemical/Chemical Plant)		
19	Serial number plate		
20	SLI		
21	TPI Certificate		
22	Colour Coding		
23	Insurance		
24	Pre Medical Check-up& Periodic Medical check-up (every 6 months) including vision test for Operator		
25	Safety Induction for Operator		
26	Others		

Signature & Name of Operator:

Signature & Name of Contractor's Concern Engineer

Signature & Name of Contractor's Safety Officer

FORMAT NO. : HSE-24 REV 0

Boom Lift Inspection Checklist

Name of Contractor: **Project:**

Name of Work: **Job No:**

Vehicle Identification/Registration No: **Date:**

Sr. No.	Description	Observation	Remarks & Suggestions
1	Operating and emergency controls are in proper working condition, EMO button or Emergency Stop Device		
2	Functional upper drive control interlock (i.e. foot pedal, spring lock, or two hand controls)		
3	Emergency Lowering function operates properly		
4	Lower operating controls successfully override the upper controls		
5	Both upper and lower controls are adequately protected from inadvertent operation.		
6	Control panel is clean & all buttons/switches are clearly visible (no paint over spray, etc.)		
7	All switch & mechanical guards are in good condition and properly installed		
8	All Safety Indicator lights work		
9	Drive controls function properly & accurately labelled (up, down, right, left, forward, back)		
10	Motion alarms are functional		
11	Safety decals are in place and readable		
12	Guardrails and anchor points are in place, and in good condition		
13	Work platform & extension slides are clean, dry, & clear of debris		
14	Work platform extension slides in and out freely with safety locking pins in place to lock setting on models with extension platforms.		
15	Any defects such as cracked welds, fuel leaks, hydraulic leaks, damaged control cables or wire harness, etc.		
16	Braking devices are operating properly		
17	The manufacturer's operations manual is stored on AWP (in all languages of the operators)		
18	Oil level, Hydraulic Oil Level, Fuel Level, Coolant Level		

19	Battery Charge		
20	Outriggers in place or functioning. Associated alarms working		
21	Tyres and wheels are in good condition, with adequate air pressure if pneumatic		
22	Wheel chokes are present and are used whenever required		
23	Moving & rotating parts guarded		
24	Load chart provided		
25	Fire Extinguisher		
26	Spark Arrestor, if operated by using fuel(For Running Refinery/ Petrochemical/Chemical Plant)		
27	Serial number plate with Load capacity		
28	TPI Certificate		
29	Colour Coding		
30	Insurance		
31	Pre Medical Check-up& Periodic Medical check-up (every 6 months) including vision test for Operator		
32	Safety Induction for Operator		
33	Others		

Signature & Name of Operator:

Signature & Name of Contractor's Concern Engineer

Signature & Name of Contractor's Safety Officer

ELECTRICAL POWER IS THE MAINSTAY OF ANY CONSTRUCTION ACTIVITY. AT THE SAME TIME IT REQUIRES UTMOST CARE IN IT'S UTILISATION TO AVOID ACCIDENTS DUE TO ELECTRICAL SHOCK, FIRE INCIDENTS OR ELECTRIC SHORT CIRCUITS. EXPOSURE OF ELECTRICAL INSTALLATION TO ADVERSE ENVIRONMENTAL CONDITIONS INCREASE THE RISK OF SUCH ACCIDENTS. HENCE IT IS NECESSARY TO TAKE EXTRA PRECAUTIONS FOR SUCH INSTALLATIONS TO ENSURE SAFETY OF PERSONNEL AND EQUIPMENT. THIS STANDARD ADDRESSES THE SAFETY MEASURES REQUIRED TO BE ADOPTED FOR THE ELECTRICAL INSTALLATIONS BY ALL CONTRACTORS DURING CONSTRUCTION PHASE.

1. ALL ELECTRICAL CONNECTIONS/WORK FOR ELECTRICAL INSTALLATIONS SHALL BE CARRIED OUT AS PER PROVISIONS OF THE LATEST REVISION OF THE FOLLOWING CODES AND STANDARDS IN ADDITION TO THE REQUIREMENTS OF STATUTORY AUTHORITIES AND CEA REGULATIONS–2010.
   OISD–STD–173 : FIRE PREVENTION AND PROTECTION SYSTEM FOR ELECTRICAL INSTALLATIONS.
   OISD–STD–192 : SAFETY PRACTICE DURING CONSTRUCTION.
   SP–30 (BIS) : NATIONAL ELECTRIC CODE.
   THE INSTALLATION SHALL HAVE APPROVAL FROM CONCERNED STATUTORY AUTHORITIES.
2. ALL ELECTRICAL CONNECTIONS SHALL BE DONE BY AN ELECTRICIAN WITH VALID LICENCE AND TO THE SATISFACTION OF ENGINEER–IN–CHARGE.
3. ONE COMPETENT LICENCED ELECTRICIAN SHALL BE MADE AVAILABLE BY CONTRACTOR AT SITE ROUND THE CLOCK TO ATTEND TO THE NORMAL/EMERGENCY JOBS.
4. ALL SWITCH BOARDS/WELDING MACHINES SHALL BE KEPT IN WELL VENTILATED & COVERED SHED. THE SHED SHALL BE ELEVATED TO AVOID WATER LOGGING. NO FLAMMABLE MATERIALS SHALL BE USED FOR CONSTRUCTING THE SHED. ALSO FLAMMABLE MATERIALS SHALL NOT BE STORED IN AND AROUND ELECTRICAL EQUIPMENT/SWITCHBOARD. ADEQUATE CLEARANCES AND OPERATIONAL SPACE SHALL BE PROVIDED AROUND THE EQUIPMENT.
5. FIRE EXTINGUISHERS AND INSULATING MATS SHALL BE PROVIDED IN ALL POWER DISTRIBUTION CENTERS.
6. TEMPORARY ELECTRICAL EQUIPMENT SHALL NOT BE EMPLOYED IN HAZARDOUS AREAS WITHOUT OBTAINING SAFETY PERMIT.
7. PROPER HOUSE KEEPING SHALL BE DONE AROUND THE ELECTRICAL INSTALLATIONS.
8. ALL TEMPORARY INSTALLATIONS SHALL BE TESTED BEFORE ENERGISING, TO ENSURE PROPER EARTHING, BONDING, SUITABILITY OF PROTECTION SYSTEM, ADEQUACY OF FEEDERS/CABLES ETC.
9. ALL WELDERS SHALL USE HAND GLOVES IRRESPECTIVE OF HOLDER VOLTAGE.
10. MULTILINGUAL (ENGLISH, HINDI AND LOCAL LANGUAGE) CAUTION BOARDS, SHOCK TREATMENT CHARTS AND INSTRUCTION PLATE CONTAINING LOCATION OF ISOLATION POINT FOR INCOMING SUPPLY, NAME & TELEPHONE NO. OF CONTACT PERSON IN EMERGENCY SHALL BE PROVIDED IN SUBSTATIONS AND NEAR ALL DISTRIBUTION BOARDS/LOCAL PANELS.
11. OPERATION OF EARTH LEAKAGE DEVICE SHALL BE CHECKED REGULARLY BY PORTABLE ELCB/RCCB TESTER.
12. THE FOLLOWING DESIGN FEATURES SHALL BE ENSURED FOR ALL ELECTRICAL INSTALLATIONS DURING CONSTRUCTION PHASE.

12.1 EACH INSTALLATION SHALL HAVE A MAIN SWITCH WITH A PROTECTIVE DEVICE, INSTALLED IN AN ENCLOSURE ADJACENT TO THE METERING POINT. THE OPERATING HEIGHT OF THE MAIN SWITCH SHALL NOT EXCEED 1.5 M. THE MAIN SWITCH SHALL BE CONNECTED TO THE POINT OF SUPPLY BY MEANS OF ARMOURED CABLE.

12.2 THE OUTGOING FEEDERS SHALL BE DOUBLE OR TRIPLE POLE SWITCHES WITH FUSES/MCBs. LOADS IN A THREE PHASE CIRCUIT SHALL BE BALANCED AS FAR AS POSSIBLE AND LOAD ON NEUTRAL SHOULD NOT EXCEED 20% OF LOAD IN THE PHASE.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
4	07.12.21	UPDATED & ISSUED AS STANDARD	JSK	VKS/HK	PG	SM
3	08.11.16	REVISED & ISSUED AS STANDARD	BP	FA/HK	BRB	RN
2	02.03.12	REAFFIRMED & ISSUED	BP	RKS/RSC	UAP/JMS	DM

12.3 THE INSTALLATION SHALL BE ADEQUATELY PROTECTED AGAINST OVERLOAD, SHORT CIRCUIT AND EARTH LEAKAGE BY THE USE OF SUITABLE PROTECTIVE DEVICES. FUSES WHEREVER USED SHALL BE HRC TYPE. USE OF REWIRABLE FUSES SHALL BE STRICTLY PROHIBITED. THE EARTH LEAKAGE DEVICE SHALL HAVE AN OPERATING CURRENT NOT EXCEEDING 30 mA.

12.4 ALL CONNECTIONS TO THE HANDTOOLS/WELDING RECEPTACLES SHALL BE TAKEN THROUGH PROPER SWITCHES, SOCKETS AND PLUGS.

12.5 ALL SINGLE PHASE SOCKETS SHALL BE MINIMUM 3 PIN TYPE ONLY. ALL UNUSED SOCKETS SHALL BE PROVIDED WITH SOCKET CAPS.

12.6 ONLY 3 CORE (P+N+E) OVERALL SHEATHED FLEXIBLE CABLES WITH MINIMUM CONDUCTOR SIZE OF 1.5 MM^2 COPPER SHALL BE USED FOR ALL HAND TOOLS.

12.7 ONLY METALLIC DISTRIBUTION BOXES WITH DOUBLE EARTHING SHALL BE USED AT SITE. NO WOODEN BOXES SHALL BE USED.

12.8 ALL POWER CABLES SHALL BE TERMINATED WITH COMPRESSION TYPE NICKEL PLATED BRASS CABLE GLANDS. LUGS OF COPPER/ALUMINIUM/BIMETALLIC MATERIAL, AS APPLICABLE SHALL BE USED FOR MULTISTRAND WIRES/CABLES HAVING MUTISTRAND/SOLID CONDUCTOR.

12.9 CABLES SHALL BE FREE FROM ANY INSULATION DAMAGE.

12.10 CABLES SHALL BE LAID IN UNDERGROUND AT A MINIMUM DEPTH OF 750 MM, FOR LV & CONTROLS AND 900MM FOR HV CABLES COVERED WITH SAND, BRICK AND SOIL FOR ENSURING MECHANICAL PROTECTION. CABLES SHALL NOT BE LAID IN WATER LOGGED AREA AS FAR AS PRACTICABLE. CABLE ROUTE MARKERS SHALL BE PROVIDED AT EVERY 25 M OF BURIED TRENCH ROUTE. WHEN LAID ABOVE GROUND, CABLES SHALL BE PROPERLY CLEATED OR SUPPORTED ON RIGID POLES OF ATLEAST 2.1 M HIGH. MINIMUM HEAD CLEARANCE OF 6 METERS SHALL BE PROVIDED AT ROAD CROSSING.

12.11 UNDER GROUND CABLES SHALL NOT BE ALLOWED TO CROSS THE ROADS WITHOUT PIPE SLEEVE.

12.12 ALL CABLE JOINTS SHALL BE DONE WITH PROPER JOINTING KIT. NO TAPED/TEMPORARY JOINTS SHALL BE USED.

12.13 AN INDEPENDENT EARTHING FACILITY SHOULD PREFERABLY BE ESTABLISHED WITHIN THE TEMPORARY INSTALLATION PREMISES. ALL APPLIANCES AND EQUIPMENT SHALL BE ADEQUATELY EARTHED. IN CASE ARMOURED CABLES ARE USED, THE ARMOUR SHALL BE BONDED TO THE EARTHING SYSTEM.

12.14 ALL CABLES AND WIRE ROPE USED FOR EARTH CONNECTIONS SHALL BE TERMINATED THROUGH LUGS OF TINNED COPPER/ALUMINIUM/ BIMETALLIC MATERIAL, AS APPLICABLE.

12.15 IN CASE OF LOCAL EARTHING, EARTH ELECTRODES SHALL BE BURIED NEAR THE SUPPLY POINT AND EARTH CONTINUITY WIRE SHALL BE CONNECTED TO LOCAL EARTH PLATE FOR FURTHER DISTRIBUTION TO VARIOUS APPLIANCES. ALL INSULATED WIRES FOR EARTH CONNECTION SHALL HAVE INSULATION OF GREEN COLOUR.

12.16 SEPARATE CORE SHALL BE PROVIDED FOR NEUTRAL. EARTH/STRUCTURES SHALL NOT BE USED AS A NEUTRAL IN ANY CASE.

12.17 ON/OFF POSITION OF ALL SWITCHES SHALL BE CLEARLY DESIGNATED/PAINTED FOR EASY ISOLATION IN EMERGENCY.

13. ALL INSULATIONS AND ELECTRICAL INSTALLATIONS SHALL BE INSPECTED BY ENGINEER-IN-CHARGE ATLEAST ONCE IN A MONTH.

Rev. No.	Date	Purpose	Prepared by	Checked by	Stds. Committee Convenor	Stds. Bureau Chairman
					Approved by	
4	07.12.21	UPDATED & ISSUED AS STANDARD	JSK	VKS/HK	PG	SM
3	08.11.16	REVISED & ISSUED AS STANDARD	BP	FA/HK	BRB	RN
2	02.03.12	REAFFIRMED & ISSUED	BP	RKS/RSC	UAP/JMS	DM

SECTION-III
(SPECIFIC PROJECT REQUIREMENTS)

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
0	05.11.24	ISSUED with MR	BO	KKP	SM

1.0 FOREWORD :

1.1 Bidder must note the following before filling up the forms enclosed in this section of the MR. Proposal not accompanying information asked as per this section shall not be evaluated.

2.0 Bidder must ensure the following while quoting:

2.1 The system as offered must meet the proven-ness requirements specified in clause 6.0 of this section.

2.2 All activities as offered shall be carried out by agency and from the location which meets the proven-ness requirements specified in clause 6.0 of this section.

2.3 In addition to clause no. 6.0 of this section, all bought-out items shall also meet the following:-

a) All bought-out items shall be designed, engineered, manufactured, fully assembled, wired and tested by the manufacturer at their works only.

b) All bought out items/ sub systems shall be fully tested at a manufacturer's shop prior to shipment by manufacturer to vendor works for assembly. All such test reports shall be submitted to Owner/ EIL for review.

c) All such sub-systems shall also be made available during integrated factory acceptance test at vendor's works.

2.4 For the bought out items, in case Bidder proposes to carryout activities by any agency other than the manufacturer then the following requirements shall be complied by the Bidder: -

a) The manufacturer of the item/ subsystem must furnish a certificate for owning full responsibility of the overall system and its performance.

b) The agency and activity location must meet the requirements specified in pare 2.2 above. The information must be filled up in the PTR format enclosed along with this requisition.

c) The manufacturer must approve all documents including software documents generated by the agency (if other than manufacturer).

d) The manufacturer's qualified, competent and regular employee must be present during all technical meetings, system integration, factory acceptance test, system start-up & commissioning and site acceptance testing.

2.5 Separate PTR form shall be filled for each system being proposed.

3.0 CERTIFICATE FOR LOGISTIC SUPPORT :

3.1 Bidder shall furnish a certificate for providing necessary support services. The certificate shall be as per the format enclosed (Annexure-I) in this section and shall be duly signed by them and their principal(s).The formats enclosed along with Annexure-I shall be complete as follows:-

Sheet 2 of 3:- To be completed and signed by Bidders principal's corporate level signatory. For Bidders who have their controlling business group corporate office overseas, it must be completed and signed by their overseas corporate official only.

Sheet 3 of 3:- To be completed and signed by Bidders corporate level signatory.

3.2 Proposals received without the certificate, or with unsigned/ unstamped certificate, or matter with revised text, or certificate not on company's letterhead shall not be considered for further evaluation.

3.3 Certificate from sub vendors for systems such as Barriers, Power Supply, Isolators, Relay, I/O cards shall also be furnished. The certificates issued by the local agents shall not be acceptable.

3.4 Bidder shall provide bidder's principal recommended antivirus software for the warranty period. However, all required software patches to fix bugs for DCS/ PLC software supplied by bidder shall be provided by bidder free of cost for the entire period of logistic support.

4.0 RESPONSIBILITY CHART :

4.1 Bidder shall fill up the "Responsibility Chart" (Annexure-II) clearly and unambiguously. Prime responsible agency shall meet the Proven Track Record (PTR) outlined in Para 2 & 6 respectively.

4.2 No shift in the responsibilities shall be entertained at a later date, during the project execution for any reason what so ever.

5.0 SYSTEM UTILITY DATA :

5.1 Power Consumption and UPS Requirement

5.1.1 Bidder must fill complete information in the form enclosed (Annexure-III) including in-rush current, and its duration for each of Control Rooms and Satellite Rack Rooms separately.

5.2 Ventilation and Air Conditioning Requirement

5.2.1 The DCS along with other systems shall be installed in Control Rooms/ Satellite Rack Rooms) normally maintained at 24 ± 2 °C. Bidder must furnish the total ventilation and air-conditioning requirement as per the enclosed form (Annexure-IV) for Control Rooms and Satellite Rack Rooms separately.

5.3 Air Quality Requirement

5.3.1 Bidder must fill complete information in the form enclosed (Annexure-V) to indicate the allowable air quality requirements for the systems i.e. DCS, PLC or any other system as indicated for Control Rooms and Satellite Rack Rooms separately. In addition bidder to note hat these control room and SRR may not have any air quality control. Limitations if any must be indicated in the same form.

5.3.2 Bidder to note that Chemical filters will be provided in the HVAC system of Owner to limit the concentration of contaminants as per clause no 5.1.4.1 of Standard specification for DCS (6-52-0055). Bidder shall confirm suitability of offered system for the same.

Chemical filters have been provided in the incoming air conditioning air to limit the concentration of contaminants below following limits:

	OUTDOOR GAS COMPOSITION	INSIDEAIRCONDITIONED SPACE (PPM by Vol.)
SO_2	13.0 ppm V	« 0.05
NO,	84.4 mg/m3	« 0.05 (NO2)
H_2S	3.5 ppm V	< 0.01
Cl_2	0,1 ppm V	< 0.001
NH_3	TRACES	< 1
SPM	487.0 mg/m3	< 200 pg/m3

All sub-systems and system components shall be suitable for operating continuously in the above mentioned corrosive environments.

6.0 PROVEN TRACK RECORD :

6.1 Bidder shall fill the “Proven Track Record (PTR)” form enclosed (Annexure-VI) in this section with information as asked for the system proposed.

6.2 Bidder to note that proven record must be available for the offered console/ controller combination as a minimum. Accordingly, information must be provided in the form.

6.3 Proposal received without properly filled PTR form not, or incomplete form, or the proposed system/ subsystem(s)/ agency responsible for any activity/ activity location not meeting basic qualification specified in clause no. 6.4 shall not be evaluated. Activities shall be as defined in Para 8.5 of Proven Track Record format.

6.4 The system/ sub-system/ bought out items and services should have been supplied and working satisfactorily for a period of minimum 4000 hours on the bid due date for a similar application in and hydrocarbon industry like refinery, petrochemical, gas processing plant etc.

6.5 The system should be supplied, engineered, integrated, tested, etc. from a factory from where the system/ sub-systems as offered/ supplied have already been supplied, engineered, integrated tested, etc.

6.6 Over and above requirements specified in clause no. 2.3 and 2.4, for system confirming to Safety Integrity level (SIL) certified by statutory authorities like TUV, etc., the basic engineering of the system comprising of system configuration diagram, system loading calculation, system scan time calculation, system network design shall be carried out by the agency on whose name TUV/ SIL certificate has been issued. Application engineering should be carried out by the agency meeting the proven-ness requirements as a minimum.

6.7 The system should be supplied by the manufacturer in the fully engineered condition or by the manufacturer’s representative/ subsidiary who have proper infrastructural facilities

SECTION-III
ANNEXURE I
(LOGISTIC SUPPORT FORMATS)

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
0	05-11-2024	ISSUED with MR	BO	KKP	SM

CERTIFICATE FOR LOGISTIC SUPPORT

(TO BE SIGNED BY BIDDER'S CORPORATE LEVEL SIGNATORY ON COMPANY LETTERHEAD)

Applicable for all major sub-systems bought-out by the vendor

(See Note)

I, ON BEHALF OF M/s_____ CONFIRM THAT THE _____QUOTED BY US THROUGH M/S_____ FOR BITUMEN MAXIMIZATION PROJECT OFFSITE TANKAGE AREA AND ASSOCIATED FACILITIES PROJECT OF M/s IOCL AGAINST MATERIAL REQUISITION B568-304- YE-MR-1501, SHALL CONTINUE TO BE SUPPORTED BY US AND OUR PRINCIPAL M/s_____ A N D QUOTED SYSTEM SHALL NOT BE WITHDRAWN FROM "INDIAN" MARKET IN NEXT THREE (3) YEARS FROM THE DATE OF PLACEMENT OF ORDER AS A MATTER OF CORPORATE POLICY.

I, FURTHER CONFIRM THAT IN CASE OF PLACEMENT OF ORDER BY M/S IOCL ON M/s_____ WE SHALL CONTINUE TO SUPPORT M/s IOCL IN PROVIDING BACK-UP ENGINEERING, MAINTENANCE SUPPORT, AND SPARE PART SUPPORT FOR A PERIOD OF NOT LESS THAN TEN (10) YEARS FROM THE DATE OF EXPIRY OF WARRANTY.

SIGNATURE WITH SEAL

(AUTHORIZED, SENIOR MANAGEMENT LEVEL)

Note:

This form has to be filled separately by the sub vendor for major sub-systems like, Barriers, Bulk Power supply, relay, isolators, IO card etc.

TECHNICAL COMPLIANCE STATEMENT

(TO BE SIGNED BY BIDDER'S CORPORATE LEVEL SIGNATORY ON COMPANY LETTERHEAD)

I, ON BEHALF OF M/s_____CONFIRM THAT THE PROPOSAL OF THE DISTRIBUTED CONTROL SYSTEM FOR BITUMEN MAXIMIZATION PROJECT AT BARAUNI OF M/S INDIAN OIL COPORATION LIMITED AGAINST MATERIAL REQUISITION No. B568-304-YE-MR-1501 MEETS ALL THE SPECIFICATIONS AND DATA SHEETS ENCLOSED WITH THIS MR.

SIGNATURE WITH SEAL

(AUTHORIZED, SENIOR MANAGEMENT LEVEL)

SECTION-III
(RESPONSIBILITY CHART)

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
0	05.11.2024	ISSUED with MR	BO	KKP	SM

NAME OF VENDOR:

NAME OF THE PRINCIPAL:

SL. NO	DESCRIPTION	RESPONSIBILITY			ACTIVITY LOCATION	REMARKS
		OWNED BY BIDDER (YES/NO)	OWNED BY PRINCIPAL (YES/NO)	OWNED BY SUB VENDOR (YES/NO)		
A	**SOURCE OF SUPPLY**					
1	Controller And Data Acquisition Subsystem i. I/O Modules ii. Power Supply Modules iii. Any Other (Please specify)					
2	Operator Console Subsystem And Engineering Console i. CPU Cabinet including Processor Modules, Memory Modules, Power Supply Modules and Communication Modules ii. Keyboards iii. Monitors iv. Any Other (Please specify)					
3	Hardwired Instruments i. PB / SS / Lamps ii. Interposing relays iii. Signal Isolators iv. Safety Barriers v. Line fault detector vi. Any Other (please specify)					
4	Programmable Logic Controller (PLC) i. I/O Modules ii. Power Supply Modules iii. Any Other (please specify)					
6	Printers and Hard copier unit					
7	Instrument Asset Management System (IAMS)					
8	Hardwired Console, Racks and Other System Racks					
9	Unit History Node (UHN)					
10	Alarm Information and Management System (AIMS)					

SL.	DESCRIPTION	RESPONSIBILITY			ACTIVITY	REMARKS
11	OPC Servers with Firewall					
B	**SYSTEM ENGINEERING**					
1	Distributed Control System (DCS) i. Basic System Design ii. Detailed System Engineering including finalizing worksheets iii. Standard Configuration and Generation iv. Logging and Report Generation v. Foreign/ Third Party Device Interface vi. System Software Loading and Debugging vii. Any Other (Please specify)					
2	Programmable Logic Controller i. Basic System Design ii. Detailed System Engineering including Finalizing Worksheets iii. Standard Configuration and Generation iv. Logging and Report Generation v. Foreign Device Interface vi. Special Software vii. System Software Loading and Debugging viii. Any other (please specify)					
3	OPC Servers with Firewall					
4	Unit History Node(UHN)					
5	Instrument Asset Management System (IAMS)					
6	Giant Screen					
7	Alarm Information and Management System (AIMS)					
C	System Integration And Factory Testing i. Factory Testing of DCS ii. Factory Testing of PLC. iii. Integrated Factory acceptance testing					
D	Installation, Field Testing & Commissioning					
E	Training i. DCS including IAMS, DON, UHN, AIMS, OPC with firewalls etc ii. PLC					

SL.	DESCRIPTION	RESPONSIBILITY			ACTIVITY	REMARKS
F	**Post Warranty Comprehensive Annual Maintenance Contract for 5 years:-** i. DCS ii. PLC iii. Instrument Asset Management system (IAMS) iv. Alarm Information and Management System (AIMS) v. Unit History Node (UHN) vi. OPC servers with firewalls vii. Any Other bought out items supplied by bidder (Please Specify)					
G	**Any Other (Please Specify)**					

NOTES:

1. Bidder must fill the form completely.
2. Information filled in this form shall be unambiguous and without any qualification.
3. In case vendor does not have any proven record, it must be backed by the collaborator and accompanied by the letter from the collaborator for the back up guarantee.
4. While filling this format Bidder must ensure that the prime responsibility shall be owned by the original equipment manufacturer of the equipment. While overall responsibility shall be owned by the bidder.

SECTION-III

ANNEXURE III

(POWER CONSUMPTION AND UPS REQUIREMENT)

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
0	05.11.2024	ISSUED with MR	BO	KKP	SM

Sl No	Item description	Unit consumption (VA)	Total Consumption (VA)	Power factor	Inrush current (A)	Duration (ms)
	Location: DDCS-III Control Room/ EPCC-11 Control Room.					
1	~~DCS Controller/ Controller File~~					
2	DCS Data acquisition I/O Modules i. 4-20mA ii. Digital input iii. Digital Output iv. Serial Interface v. Any other Module (Please specify)					
3	~~DCS Controller & Data Acquisition Cabinet with maximum loading~~					
4	DCS Marshalling Cabinets					
5	~~DCS Operator console, with electronics & monitor only~~					
6	~~DCS Engineering station, with electronics & monitor only~~					
7	~~PLC Processors~~					
8	PLC I/O Modules i. 4-20mA ii. Digital input					

	iii. Digital Output iv. Any other Module (Please specify)					
9	PLC ~~processor and~~ I/O cabinet with maximum loading					
10	PLC Marshalling Cabinets					
11	~~PLC Engineering Station, with electronics & TFT only~~					
12	~~PLC SOE station, with electronics & TFT only~~					
13	~~PLC Operator station, with electronics & TFT only~~					
14	~~F&G Engg cum Operator console~~					
15	Hardwired consoles, with instruments installed					
16	~~Hard copier unit~~					
17	~~Multi-purpose printer~~					
18	~~C & M printer /Network Printer~~					
19	~~Instrument Asset Management System~~					
20	Foreign device interface, if mounted separately and as applicable i. ~~PLC Interface~~					

	ii. CCTV system and Monitors ~~iii. Stack Analyzer system~~ ~~iv. Wireless Gateway~~ ~~v. Any other (Please specify)~~					
21	~~OPC Servers with firewalls~~					
22	~~Documentation Node~~					
23	~~Alarm Information & Management System~~					
24	~~Network Components~~					
25	~~DMZ Firewall~~					
26	~~PLC Operator console~~					
27	~~UHN Servers~~					
28	~~GPS Master Clock~~					
29	Any other (Please indicate)					

TOTAL POWER CONSUMPTION IS _____VA @ _____LEAD/ LAG POWER FACTOR

TOTAL IN-RUSH CURRENT IS _____A FOR A PERIOD OF _____milliseconds

ACTUAL UPS REQUIREMENT _____VA UPS SIZING FACTOR (IF APPLICABLE)

UPS SIZE IS _____VA @ _____LEAD/LAG POWER FACTOR WITH IN-RUSH CURRENT OF _____A FOR _____milliseconds

SECTION-III
ANNEXURE IV
(VENTILATION & AIR CONDITIONING REQUIREMENTS)

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
0	05-11-2024	ISSUED with MR	BO	KKP	SM

NAME OF VENDOR:

Sl. No.	Item description	Unit load (kcal/hr)	Total load (kcal/hr)	Temp. Limits for operation (^{o}c)	Humidity limits for operation (%)	Temp. Limits for storage (^{o}c)	Humidity limits for storage (%)	Operating time without air-conditioning (s)
	Location: For Panels-Existing DDCS-III Control Room; For Existing Consoles -EPCC-11 Control Room							
A	**Console Area**	NA	NA	NA	NA	NA	NA	NA
1	DCS Operator console, with electronics & monitor only							
2	Hardwired consoles, with instruments installed							
3	PLC operator console, with electronics & TFT only							
4	SOE Console, with electronics & TFT only							
5	CCTV Monitor 43”							
6	Network Components							
7	Network Printer							
8	Any other (Please indicate)							

TOTAL HEAT LOAD_____kCAL/h

Sl. No.	Item description	Unit load (kcal/hr)	Total load (kcal/hr)	i. Temp. Limits for operation (°c)	Humidity limits for operation (%)	Temp. Limits for storage (°c)	Humidity limits for storage (%)	Operating time without air-conditioning (s)
B	**Engineering Room Area of SRR**							
1	DCS Engineering station, with electronics & monitor only							
2	PLC Engineering station, with electronics & monitor only							
3	PLC SOE Station							
4	Hard Copier Unit							
5	Multipurpose printer							
6	C&M cum SOE printer							
7	Instrument Asset Management System							
8	OPC Servers							
9	Buffer Servers							
10	Alarm Information & Management System							
11	Network Components							
12	UHN servers							
13	Any other (Please indicate)							

TOTAL HEAT LOAD_____kCAL/h

Sl. No.	Item description	Unit load (kcal/hr)	Total load (kcal/hr)	Temp. Limits for operation (°c)	Humidity limits for operation (%)	Temp. Limits for storage (°c)	Humidity limits for storage (%)	Operating time without air-conditioning (s)
C	**Rack Room**							
1	DCS Controller/ Controller File							
2	DCS Data acquisition I/O Modules i. 4-20mA ii. Digital input iii. Digital Output iv. Serial Interface v. Any other Module (Please specify)							
3	~~DCS Controller & Data Acquisition Cabinet with maximum loading~~							
4	DCS Marshalling Cabinets							
5	~~PLC Processors~~							
6	PLC I/O Modules i. 4-20mA ii. Digital input iii. Digital Output iv. Any other Module (Please specify)							
7	PLC ~~processor and~~ I/O cabinet with maximum loading							
8	PLC Marshalling Cabinets							
9	Foreign device interface, if mounted separately and as applicable							

Sl. No.	Item description	Unit load (kcal/hr)	Total load (kcal/hr)	Temp. Limits for operation (°c)	Humidity limits for operation (%)	Temp. Limits for storage (°c)	Humidity limits for storage (%)	Operating time without air-conditioning (s)
	~~i. PLC Interface~~ ii. CCTV system ~~iii. Analyzer system~~ ~~iv. Wireless Gateway~~ v. ~~Any other (Please specify)~~							
10	Network Components							
11	Power distribution cabinets							
12	~~DMZ Firewall~~							
13	Any other (Please indicate)							

TOTAL HEAT LOAD_____kCAL/h

SECTION-III
ANNEXURE V
(AIR QUALITY REQUIREMENT)

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
0	04-11-2024	ISSUED with MR	BO	KKP	SM

NAME OF VENDOR:

SYSTEM: DCS

Vendor / Sub Vendor: ……...

Sl. No	Maximum Allowable Concentration of	All cabinets	All consoles including Keyboards	All Disks & Disk Drives	All Printers
1	CORROSIVE GASES (in ppm) i. Hydrogen Sulphide ii. Sulphur Dioxide iii. Chlorine iv. NO/ NO2/ NOx v. Any Other (Please Specify)				
2	i. Maximum Dust concentration (in g/m3) ii. Dust Particle Size				

SYSTEM: PLC

Vendor / Sub Vendor: ……...

Sl. No	Maximum Allowable Concentration of	All cabinets	All consoles including Keyboards	All Disks & Disk Drives	All Printers
1	CORROSIVE GASES (in ppm) i. Hydrogen Sulphide ii. Sulphur Dioxide iii. Chlorine iv. NO/ NO2/ NOx v. Any Other (Please Specify)				
2	i. Maximum Dust concentration (in g/m3) ii. Dust Particle Size				

SECTION-III
ANNEXURE VI
(PROVEN TRACK RECORD)

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
0	04-11-2024	ISSUED with MR	BO	KKP	SM

Sl. No	Description	As offered for this project	System as installed @ site 1	System as installed @ site 2	System as installed @ site 3	System as installed @ site 4
1	Name of the Plant					
2	Name, Address, Telephone No./ Fax No. & E-mail of the contact person in the Plant					
3	Name, Address, Telephone No./ Fax No. & E-mail of the contact person of the Consultant					
4	Month & Year of System Supply					
5	Month & Year of System commissioning					
6	Any major breakdowns till date					
7	If Yes, Cause of Breakdown					
8.1	System details & Model No. for ~~i. DCS system with all operational and engineering data base~~					
8.2	System Used for: ~~i. Overall Regulatory Control & Data Acquisition~~ ~~ii. Data Acquisition only~~ ~~iii. Package Units Only~~ ~~iv. R&D/ Pilot Plant Only~~					

8.3	Major Subsystems ~~i. Number of Controller & Data Acquisition Subsystem offered~~ ~~ii. Model Number of Controller modules~~ iii. Model number of I/O Modules - Analog - Digital ~~iv. Number of operator Consoles~~ • ~~Model No……~~ v. ~~Number of Engineering station~~ • ~~Model No……~~ vi. Independent PLC for ESD along with Process Interlocks & Controls • ~~Make & Model No. of Processor~~ …… • Model number of I/O Modules - Analog Input Module - Analog Output Module - Digital I/O Module • ~~Number of PLCs~~ vii. Independent PLC for Fire & Gas Detection • ~~Make & Model No. of Processor~~…… • Model number of I/O Modules - Analog - Digital ~~viii. PLC interface with the DCS:~~ • ~~Directly on DCS network as part of same family~~					

	• ~~Serial Interface through Gateway~~ • ~~Hardwired~~ ~~ix. Any other Foreign Device Interface~~ • ~~Package PLC~~ • ~~Analyzer System~~ • ~~Wireless Gateway~~ • ~~Any Other~~ ~~x. OPC interface and server model no. with~~ ~~a. Offered Architecture (DA/IDA/UA etc.)~~ ~~b. Unified Architecture, if available and offered~~ ~~xi. Instrument Asset management System~~ ~~xii. Alarm Information & Management system~~ ~~xiii. Buffer Server~~ ~~xiv. CCTV Monitors~~ ~~xv. Unit History Node (UHN)~~ ~~xvi. GPS Master Clock~~					
8.4	<u>System Details</u> i. Number of Open Loops for DCS ii. Number of Closed Loops for DCS iii. Number of Graphic Pages iv. Number of Historic trend Points v. MIS Reports					

	~~vi. Advance Control~~ vii. Number of Analog inputs for PLC viii. Number of Digital I/Os for PLC					
8.5	Scope of Vendor Responsibility i. Design & Supply ii. System Engineering iii. Installation iv. Testing v. Commissioning vi. Training					
8.6	~~Salient Features of the offered System over the earlier installed~~					

SECTION-IV
(PROJECT SPECIFICATIONS)

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
0	05-11-2024	ISSUED with MR	BO	KKP	SM

TABLE OF CONTENT

SECTION-IV
(PROJECT INFORMATION)

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
0	04.11,.24	ISSUED with MR	BO	KKP	SM

1. INTRODUCTION

1.1. The offer shall be compiled in line with 'Vendor's Proposal Outline' in Section-VI.

1.2. Definitions

The following definitions shall apply for this document:

Owner	:	M/s Indian Oil Corporation Limited (M/s IOCL)
Consultant	:	M/s Engineers India Limited (M/s EIL)
Vendor	:	DCS Vendor
Purchaser	:	M/s IOCL / M/s EIL
Site	:	Barauni Refinery, Barauni, Bihar, India

2.0 PLANT DESCRIPTION:

2.1 M/s Indian Oil Corporation Limited (M/s IOCL) is setting up 06 nos new offsite Bitumen product storage tanks and associated Pumping facilities for storage and handling of Bitumen which shall be produced by new Biturox-II unit under Bitumen Maximization project of its Barauni Refinery. Control and monitoring of these new offsite Tankages and associated facilities shall be done from EPCC-11 control room through Honeywell make existing DCS/PLC and F&G system. The marshalling facilities for this DCS/PLC system shall be installed in existing DDCS-III control room new allocated rack room area .

This Material Requisition (MR) is for the augmentation of existing Distributed Control Systems along with Programmable Logic Controllers and their associated subsystems for the following units:

UNIT	UNIT No.
Offsite Tankages and associated facilities	304

2.2 The Control System described in this requisition comprises of augmentation of existing DCS and PLC along with their associated subsystems. The existing Control System of EPCC-11 shall permit Operation, Monitoring and Controls of the Units from the EPCC-11 Control Room of the Refinery as shown in the overall control system block diagram.

2.3 The Refinery shall have Existing Offsite DDCS-III Control Room . The signals of offsite tankage area and associated facilities shall be interfaced with existing DCS /PLC and F&G system of EPCC-11 with additional hardware and IO card which shall be placed in existing DDCS-III control room new allocated rack room area. Control and monitoring of the above shall be done from existing EPCC-11 control room Honeywell make Control system.

2.4 The cable distances between Process Units, CR and Substation are as given below:-

From	Control Room	Approx. Distance from Unit to CR (in Meters)	Sub-Station	Approx. Distance from Control Room to Sub-station (in Meters)
Offsite Tankages	DDCS-III Control room	1100	Offsite new substation	1500
Offsite Pump House	DDCS-III Control room	1500	Offsite new substation	1500

From	Control Room	Approx. Distance in Meters)
EPCC-11 Control room	DDCS-III Control room	150

3.0 PLANT DATA :

3.1 The plant area is generally electrically hazardous and following philosophy has been followed for instrumentation system design. Instrumentation shall be intrinsically safe for Zone-1 for inputs to DCS except instruments (like analysers etc) where intrinsically safe instrumentation is not available as standard and flameproof / purged instrumentation shall be used. Intrinsically safe instrumentation philosophy shall also be applicable for all contact inputs and outputs in hazardous area and all analog signals to PLC. Instrumentation for MCC shall be non-hazardous. All instruments shall be certified intrinsically safe for given gas group.

In general Area classifications for the units are as follows:-

Unit	Electrical Area Classification
Offsite tankage	Zone 2, Gas Group IIA,IIB,IIC
Pump station	Zone 2, Gas Group IIA,IIB,IIC

All field equipments have the approval of local statutory authority i.e. Petroleum Explosives Safety Organization (PESO). Accordingly, all associated equipment requiring certification
e.g. barriers etc. supplied by vendor shall also have the valid approval from local statutory authority i.e. PESO for Zone 1, Gas Group IIA, IIB, IIC.

3.2 Ambient Conditions: The site environmental conditions are as follows:

Maximum ambient temperature	46º C
Minimum ambient temperature	5º C
Relative humidity	65% @ 46°C
Maximum recoded rainfall	65 mm in 1 hour

3.3 **Control Room Concept**

3.3.1 The Offsite Tankage area and product pump house facilities shall be controlled and / or monitored from existing EPCC-11 Control Room through existing control system(Honeywell make) and existing console area as mentioned above and shown in the System Configuration Diagram. This shall provide total plant information to the plant operators and plant managers simultaneously at one location of this unit.

3.3.2 As shown in the System Configuration Diagram, the DCS and PLC related cabinets of i.e. marshalling and system cabinets shall be installed in the rack room of the existing DDCS-III control room rack room area of the Refinery with control and monitoring from EPCC-11 existing Control system from EPCC-11 control room. Refer Overall Plot Plan attached elsewhere in the MR for location of the Existing DDCS-III control room.

3.4 The specification/requirements given in this MR shall be met for each DCS/PLC system and their associated hardware/software and subsystems unless specifically stated otherwise. Any specific licensor requirement shall also be met as stated elsewhere.

SECTION-IV
(SPECIAL INSTRUCTIONS TO VENDOR)

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
0	04.11.2024	ISSUED with MR	BO	KKP	SM

1.0 GENERAL

1.1 Vendor to note that they shall be fully responsible to comply to the total scope of work indicated in the MR on 'Single Point Responsibility Basis' meeting all the functional requirements specified in this requisition, through hardware and software during detail engineering and accordingly vendor shall be fully responsible for the Bill of Material submitted by them.

Vendor to note that this MR comprises of the Augmentation existing DCS/PLC and F&G system to accommodate the signals of offsite Tankage area and product pump station of New Bitumin Maximization project of IOCL Barauni , Refinery.

Vendor shall furnish bottom line (lumpsum) price of the same as per item summary of this MR.

Vendor to note that Offsite tankage area and product pump area signals shall be integrated to existing Honeywell make DCS/PLC and F&G system located at EPCC-11 control room and the marshalling panels of the same shall be installed in existing DDCS-III control room (rack room area)of Offsite .

Vendor (OEM) shall be fully responsible for proper engineering, integration, installation, performance and operation of all equipment including I/O and marshalling racks, and bought-out items supplied by them as per the requirement.

Further the following are vendor's scope/responsibility:

a) Interfacing of all serial interfaces from various Purchaser's systems such as Existing RTDBMS, etc located within or outside Existing DDCS-III control room of Offsite shall be in the scope of Purchaser.

b) Spares as specified in the MR.

c) Vendor (OEM) shall be responsible to integrate the signals of Offsite tankage area and product pump area to existing AIMS, UHN and IAMS system. Vendor shall carry out the site survey and coordination with purchaser for the same.

1.2 In case of conflicts with respect to specifications, datasheet and any other engineering requirement or statutory regulations, the order of precedence for selecting the DCS and PLC system shall be.

-statutory regulations,
-data sheets, this SIV and drawings
-Standard specifications.

1.3 System Modification / Change Management.

a) Vendor (OEM) shall carry out all the modifications / changes / revisions necessary to be incorporated and pointed out at the time of FAT including graphic changes, wiring changes, I/O assignments, logic changes etc.

b) Vendor (OEM) shall carry out all changes/modifications/revisions which are to be carried out during installation including additional inputs for sub-package items, configuration of new tags, termination changes, incorporation of cable schedule corrections, modification and addition of new graphics, modification of group, trend history etc.

c) Vendor (OEM) shall carry out any changes required during loop checking and pre-commissioning activities such as range change, graphic display changes, reassignment of I/O, termination changes etc for offsite tankage and pump area only as per this MR.

d) Vendor (OEM) shall carry out changes / modifications required in the system during commissioning and start up due to operational requirements like graphic changes, tag reassignment, tags new assignment, history trend and grouping, format changes, set point range changes, logic modifications etc.

e) Vendor (OEM) scope shall include incorporation of all such software / hardware configuration, engineering changes that may occur for normal engineering project execution.

f) Vendor to support site till commissioning of last unit and SAT without any implication to the purchaser.

g) The above changes / modification shall be carried out by DCS vendor (OEM) without any time and cost implications as long as the I/O quantity specified in the I/O summary table including installed spares does not increase. Coordination with OWNER/Consultant and other sub-contractors for gathering information necessary for generation of point data base, hardware connectivity i.e. cable laying, termination details in cabinet / panel wherever necessary for vendor to complete the job. Vendor is required to visit site and gather all necessary information regarding the existing system and existing hardware available. Vendor to note that relevant documents may not be available and required information may have to be gathered from the installed system by visual inspection.

1.4 Vendor to note that Purchaser reserve the right to associate their personnel at any or all stages of project execution. Further, vendor shall not proceed without getting prior approval from purchaser for the documents required to be approved under “Vendor Data Requirement”.

1.5 Vendor is required to get prior approval from purchaser in case he plans to sub-contract a part of their site activity job to any other Vendor.

1.6 The storage of items / equipment at site shall be vendor’s responsibility for all the items / equipment’s supplied by them.

Storage space shall be provided by purchaser at site for vendor supplied equipment / systems / materials. However, the storage at site for all these items shall be under vendor’s custody and responsibility. Vendor to ensure that there shall not be any ingress of moisture to the electronic panels & cards/components. Vendor’s responsibility to ensures storage of the complete system safely and securely till the final commissioning/ handing over. The packing, coverage space shall be identified by vendor during detail engineering. Handling of material at site is vendor’s responsibility. Vendor’s responsibility to ensures storage of the complete system safely and securely till the final commissioning/ handing over.

Following activities shall be under the scope of vendor:

- Unloading of all vendor supplied systems and materials at the Storage area.
- Transportation of all vendor supplied items / equipment / systems / materials from
- Storage area to the designated Control Room.

Installation of all Cabinets and consoles supplied by the vendor in the DDCS-III Control room Rack room area.

No ware-house shall be provided for storage of system at site, only open space will be provided and vendor shall be responsible to store the same at their own risk and cost. The packing, coverage space shall be identified by vendor during detail engineering. Handling of material at site is vendor’s responsibility.

1.7 The loop checking shall be carried out in co-ordination with various Contractors, package vendors, purchaser / Field Vendors / site contractor, Purchaser in accordance with standard specification for DCS (6-52-0055) and the requirements given in MR. It is essential that dedicated team of skilled personnel consisting of minimum one engineer (each for DCS and PLC) with group of technicians from vendors side shall be provided at site for each process unit so that the execution activities such as installation, loop checking, pre-commissioning, commissioning, SAT are independently and conveniently done as required. For detail schedule, Vendor shall also refer commercial section of the MR.

1.8 Control system shall also meet any Licensor specific requirements during engineering, commissioning, as needed within the hardware required as per MR. Licensor documents shall be given to the vendor during detailed engineering.

Vendor shall be required to sign confidentiality and secrecy agreements for nondisclosure & limited use of licensor documents/ information.

1.9 **Power supply**:

1.9.1 **110 VAC UPS**:

1.9.1.1 110V AC UPS supply shall be provided by Purchaser in Control room from purchaser UPS ACDB.

1.9.1.2 The 110 VAC UPS power distribution shall be as per drawings B568-304-16-51-31001 Rev0 enclosed in Section V of this requisition. For the DCS loads, grounded UPS power supply shall be provided. For the non-DCS loads, Purchaser shall provide separate set of grounded and isolated redundant UPS power supply through isolation transformers.

1.9.1.3 UPS feeders from ACDB in UPS room to PDB in Rack Room for DCS as well as non-DCS loads shall be separate and redundant. Further distribution of DCS loads from Rack Room PDB shall be through redundant feeders by vendor.

1.9.1.4 The feeder / feeders between the UPS & the DCS Power Distribution cabinets shall be sized by Purchaser and sizes of these cables shall be provided during detail engineering. The supply of the cable, glanding, isolators, switches / fuses / MCB's as required including isolating transformer, installation and termination at UPS side shall be by Purchaser. However, glanding & termination including providing isolators, switches / fuses/ MCBs for each incoming feeder at DCS Power Distribution cabinet side is under DCS vendor's scope. Redundant cable shall be provided which will be terminated at both ends along with the MCBs, to cater for the needs whenever there is fault in the main feeders.

1.9.1.5 Suitable Zone defender AC surge protector for all AC UPS incoming feeders shall be provided in the Power distribution cabinets by the vendor.

1.9.1.6 UPS Power supply incoming feeder failure alarm at PDB shall be provided in DCS by using double pole MCB in PDB. One contact of these MCBs shall be wired to DCS for alarm purpose. I/Os required for the same shall be considered and calculated by vendor over and above I/Os required as per I/O summary table.

1.9.1.7 Purchaser's UPS feeders from ACDB in UPS room to DCS vendor's PDB in Rack Room for DCS, ESD PLC as well as non-DCS loads shall be separate and redundant. The Purchaser's incoming Redundant (R) Feeders to the vendor's PDB in the rack room for the DCS loads and the non-DCS loads shall be as follows:-

Sr.No	Unit	Load (KVA)	No.of feeders
Offsite control room Rack room			
1	DCS System	4	1+1 (R)
2	PLC System	3	1+1 (R)
3	F&G PLC system	3	1+1 (R)
4	Network System	2	1+1 (R)
5	NON DCS system CCTV	2	1
6	NON DCS TFMS system	3	1
9	NON DCS LOAD	5	1

1.9.1.8 DCS system load shall be calculated considering:

a) Expandability of I/Os including installed spares and installed future spare space.

b) In rush current and power factor for system/user load.

1.9.1.9 For UPS AC redundant power supply incomer in the rack room PDBs, Automatic Transfer Switches (ATS) shall be considered for non-redundant DCS and non-DCS loads in respective PDBs in rack room by vendor. Power supply for all subsystems, where facility is available for accepting redundant supplies, shall be from redundant power source and not from ATS.ATS shall have serial communication for status and diagnostics reporting in DCS. Serial I/Os required for the same shall be considered and calculated by vendor over and above required as per I/O summary table.

1.9.1.10 For the Non-DCS loads, Vendor shall provide individual feeders in the vendor (OEM) supplied PDB in the Rack Room for each unit as per feeder details given in the list enclosed in Section-V, Annexure-VIII. The actual number of feeders and feeder ratings shall be finalised during detail engineering within the total rating of non-DCS UPS load identified for the vendor supplied PDBs.

1.9.1.11 For major non-DCS loads (>1.5KVA), the feeders shall be provided directly from the UPS ACDB in the UPS Room.

1.9.1.12 Isolation transformers shall be provided by Purchaser for each non-DCS feeder from the UPS ACDB and these isolation transformers shall be located in the UPS room.

1.9.1.13 The supply and laying of power supply cables from the vendor supplied non-DCS feeders in the cabinet to the consumers in field are not in DCS vendor's scope, however glanding and termination at vendor's cabinet shall be carried out by vendor including supply of glands, lugs, TBs and ferrules etc.

1.9.1.14 The supply and laying of power supply cables from the vendor supplied non-DCS feeders in the cabinet to the consumers in DDCS -III control room and EPCC-11 Control Room are in DCS vendor's scope including termination, glanding and ferruling at both end.

1.9.1.15 20% or minimum one no. redundant Spare feeder whichever is higher shall be provided by the vendor for each feeder rating over and above specified in Section-V Annexure-VIII.

1.9.1.16 No automatic sequential start-up is required for any power supply.

1.9.1.25 Vendor to refer M/s IOCL's Report of Reliability Improvements Volume 1 enclosed in Section-IV of the MR and also comply with the requirements given in Part-C Chapter-11 (Instrumentation Power Distribution System).

1.9.2 <u>240 VAC non UPS</u>:

1.9.2.8 Multiple feeders shall be provided with each feeder of rating 240V, 16A catering to a maximum of ten nos. cabinets in each row. The 240 VAC feeders shall be provided at one place (at 240V AC PDB supplied by vendor) at SRRs by purchaser and further distribution including power distribution cabinet shall be in vendor's scope. The actual

No of feeders to be provided by Purchaser shall be finalised based on information from DCS vendor during detail engineering.240V AC PDB .

1.9.2.9 The 240 VAC power distribution shall be as per typical drawings enclosed in Section V of this requisition.

1.9.2.10 The power supply cables corresponding to these multiple feeders shall be laid upto the DCS vendor's power distribution cabinets by others and glanding, termination of these cables shall be in vendor's scope. The cabling from the vendor's PDB corresponding to these feeders to the individual row of cabinets shall be by the vendor and vendor shall further consider series wiring of the individual cabinets(including Non-DCS cabinets) in the row for each cabinet illumination shall be by vendor. Each feeder from DCS PDB will be used to power a set of at least ten cabinets in one row in each rack room.

1.9.2.11 Vendor shall use suitable lighting arrangement for the System cabinets housing the controllers / processors, so that cabinet illumination does not cause interference in the performance of these controllers/ processors.

1.9.2.12 Vendor shall also provide feeder from their PDB as well as power supply cables for panel illumination of the Purchaser's cabinets located in the Rack Rooms. Vendor shall consider maximum 05 nos. Purchaser's Cabinets which can be accommodated spread over cabinet rows after placing all the DCS cabinets as per the attached DDCS-III control room and EPCC-11 Control room.layouts.

1.9.2.13 For DCS and PLC, Non-UPS power shall be used for Lighting & Fan.

1.9.3 Bulk Power Supply (BPS):

1.9.3.1 Power supply distribution other than 110VAC UPS and 240V AC non UPS shall be provided using dual redundant Bulk Power Supply (BPS) by vendor(OEM).

Each Bulk power supply shall be fed from UPS and the primary and secondary UPS feeders shall independently source the primary and secondary BPS of each redundant BPS set respectively.

1.9.3.2 Each redundant bulk power supply shall be sized for 25% loading of its capacity in normal time; the maximum loading of each BPS is to be 70%(Max.) of its rated capacity during failure of one of the redundant BPS. Vendor to ensure that barriers / isolators are fed individually from the BPS supply without any looping between adjacent barriers/ isolators.

1.9.3.3 All bulk power supply (BPS) shall be provided with surge protection capability. Each BPS to have own individual Diode/Mosfet OR-ing module (cross connected). Mosfet based O-ring modules shall be provided at the BPS output in conjunction with Diode-O-ring modules for balanced load sharing between two BPS in redundant configuration. Redundant Mosfet based O-ring modules to be considered (One each for individual power supply). Each Mosfet based O-ring should have 2 inputs from separate power supply (cross connected with each of the redundant BPS). BPSs and mosfet orings failure alarm indications shall be provided in DCS with graphics for each of the redundant component. Each BPS supply shall also have 4-20mA output wiring to DCS for status monitoring with DCS graphics. I/Os required for the same shall be considered and calculated by vendor over and above I/Os required as per I/O summary table. BPS shall be with redundant MOSFET O-Ring with local indication of healthiness.All bulk power supply (BPS) shall also be provided with cooling system as per manufacturer standard. The power supply and redundancy modules shall be separate, and each module shall be replaceable easily and Hot swappable.

1.9.3.4 All BPS's and Mosfet O-ring modules shall be from reputed vendors. PLC power supply units shall be TUV certified.

1.9.3.5 Each BPS shall be provided with MOSFET based redundancy with auto current balancing and equal loading on both BPS.

1.9.3.6 The BPS used for powering the 3-wire gas detectors shall at least have 28V DC power supply output.

1.9.3.7 All the system Power cables from PDB at rack room to DCS vendor supplied items including cabinets etc. within control rooms/SRRs shall be supplied by Vendor. For all vendor supplied power supply cables, glanding and termination shall be in vendor's scope at both ends. For other Non-DCS loads in fields where supply of cables are not in vendor's scope, glanding and termination at vendor supplied PDB shall be in vendor's scope.

1.9.3.8 Fan failure device and temperature detection / alarm shall be provided for each cabinet/console. For marshalling cabinets, a common temperature and fan failure alarm for a group of maximum 10 cabinets or one row of cabinets, whichever is lower, shall be annunciated in DCS. However, for system cabinets, combined temperature and fan failure alarm shall be annunciated in DCS individually for each cabinet. For consoles, a common temperature and fan failure alarm for a group of maximum 10 consoles or one row/arc of consoles, whichever is lower, shall be annunciated in DCS. I/Os required for the same shall be considered and calculated by vendor over and above I/Os required as per I/O summary table..

1.9.3.9 Vendor shall provide BPS 24VDC feeders for owner's use in as per the list given in Section-V Annexure-IX along with MCB for each feeder.

1.9.3.10 All Power supply subsystem shall be redundant (1:1 redundancy). Redundancy shall be provided to ensure availability of the system at single point failure.

1.9.3.11 Each feeder in PDB shall have outgoing feeder MCB. In all cabinets/consoles incoming MCB shall be considered for power incoming feeder. Further MCBs shall be considered for each load wise distribution inside each panel.

1.9.3.12 DCS vendor shall prepare the project schedule for all the items during detail engineering and submit the same for purchaser review and approval.

2.0 SPECIFIC REQUIREMENTS FOR DCS/PLC/OTHER SYSTEMS:

2.1 **DCS**

The DCS shall be with the following basis of implementation:

2.1.1 All Control and monitoring such as Open Loop, Close loop control and monitoring shall be carried out through Conventional SMART (4-20mA with HART) technology. The Controller subsystem shall be sized considering all control algorithm / controller function executed in DCS.

2.1.2 Status indication from MCC to DCS shall hardwired wherever identified in the I/O summary and the System Configuration. Outputs from DCS to VFD shall be through Hardwired only.

2.1.3 All hardwired signal /cable interfaces between MCC and SRR, shall take place at an Instrument/Electrical Interface Cabinet also termed as IRP –Interposing Relay Panel. The Interface Cabinet shall be located in the Rack room.

2.1.4 All hardwired Digital inputs and outputs between DCS and field/ MCC shall be through potential free contacts.

2.1.5 For split range control, if any, the controller shall provide two independent output signals one for each control valve.

2.1.6 Graphic, control Groups, Trends, logs and reports shall be approved by purchaser prior to start of engineering/ implementation.

2.1.7 The Network cabinet shall be free standing type and shall be located in the Rack Room of Control room.

2.1.8 All parameters like cabinet temperature (4-20 mA signal) of system cabinet to be programmed in DCS graphics. Pre-alarm shall also be provided for the same in the Operator console Also, for each AC UPS PDB, Voltage indication shall be repeated in DCS.

2.1.11 All parameters like cabinet temperature (4-20 mA signal) of system cabinet to be programmed in DCS graphics. Pre-alarm shall also be provided for the same in the Operator console Also, for each AC UPS PDB, Voltage indication shall be repeated in DCS.

2.1.12 DCS shall be equipped with a dedicated page(s) for Gas detectors.

2.1.13 All critical loops should be configured for “Output tolerance alarm” and “Set Point Tolerance alarm”. This feature will generate an alarm when an operator changes “Set point” or “output” beyond the pre-defined tolerance percentage. The critical loops shall be identified during detailed engineering.

2.1.14 Command from Soft PB on DCS operator HMI if applicable for valve open/close, motor start/stop to PLC/F&G shall be hardwired.

2.1.15 Vendor to refer M/s IOCL’s Report of Reliability Improvements Volume 1 enclosed in Section-IV of the MR and also comply with the requirements given in Part C Chapter-13 Process Monitoring and Alarm Management System).

2.2 **PLC**

2.2.11 The interlocks and shutdown signals shall be executed through Programmable Logic Controllers with analog input from SMART transmitters (4-20mA with HART), contact signals input/ output between field / MCC. Wherever Licensor have specifically indicated interlock and sequence logic execution in DCS, the same shall be carried out accordingly.

2.2.12 Wiring for Inputs and outputs to the PLC system shall be as per the OEM recommended philosophy. The PLC FTA shall be from the OEM and shall be as per the TUV certificate. Any I/O multiplication hardware required for wiring of the field inputs to PLC I/O module as per standard architecture of the PLC shall be TUV certified meeting requirements of SIL3 as specified.

2.2.13 The main PLC I/O cards replacement should be possible on line without compromising the plant safety and TUV guidelines. All PLC redundant I/O cards shall be hot swappable. Removal/replacement of anyone I/O card shall not lead to signal drop/loss.

2.2.14 All Interposing relays shall be SIL-3 certified. However, for Interposing relays used in HT motor (55KW) trip circuits, TUV certified non-SIL relay is also acceptable. For barriers of PLC, both SIL-3 and SIL-2 certified barriers are acceptable. The power supply module mounted on the processor / I/O racks shall also be TUV SIL-3 certified as part of the TUV certification of the PLC system.

2.2.15 Instrumentation shutdown and interlock shall be de-energizing to trip.

2.2.16 The PLC programming terminal shall not be online under normal operating conditions (either powered off or have multiple password protection).

2.2.17 Logic diagrams shall only be used for PLC programming. Ladder diagrams are not acceptable. Logic diagrams submitted by vendor shall be in ISA format and not ladder logics.

2.2.18 DCS / PLC hardware (except consoles) shall be suitable for use in G3 environment. The DCS and PLC cards / modules in the SRR shall also be suitable for the environmental conditions specified in the “Standard Specification for DCS doc. No. 6-52-0055) and any

necessary coating, if required on the cards / modules for smooth and trouble-free operation of the same, shall be provided by the vendor. The conformal coating should be from the manufacturing facility only.

2.2.19 Vendor to note that , as per Clause no 6.3.1.2 of Part-I of Standard Specification of DCS 6-52-0055, vendor to note that Separate marshalling cabinet shall also be considered for IS and Non-IS signals. Also DI and DO shall be separate**.**

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2.3 **I/O ASSIGNMENT PHILOSOPHY**

The I/O assignment philosophy shall be as per clause 6.5 of Standard Specification 6-52-0055. The total quantity of cards for each type of I/O shall be arrived at after adding installed spare percentage (20%) on the basic I/O count provided in the I/O Summary Table and then dividing it by no. of channels offered / selected for each type of I/O card and rounded up to next whole number. In addition, the following I/O assignment philosophy for each unit to be considered as given below.

2.4 Each DCS/ PLC cabinets/console shall have static electricity discharge strip.

2.5 Proximity probe input to PLC/DCS shall be provided with IS barrier cum pre-amplifier.

2.6 For repeat indication of analog input signals to field mounted remote output meters, the following philosophy to be followed:

a) For DCS conventional close loop inputs and PLC interlock inputs, the repeat indication to remote output meter in field shall be through DCS AO card only.
b) For DCS conventional open loops, remote output meter shall be loop powered.

2.7 For UPS diagnostic data, a serial link shall be considered from UPS to respective DCS.

2.8 **Redundant process signal segregation**

The I/O of redundant process signals (in 2oo3, 1ooN etc. configuration) shall not be configured in the same I/O module and shall be distributed among different I/O modules in different racks.

2.9 **Equipment wise Segregation**

The I/O of process equipment (Transmitter A/B/C, Pumps A/B/C etc.) shall not be configured in the same I/O module and shall be distributed among different I/O modules. Any redundant / duty stand-by machines (e.g. compressors, pumps) and parallel running equipments (e.g. heaters) shall be assigned to different I/O modules in different racks.

2.10 **Analog & Digital signals segregation**

Analog and digital signals shall be assigned to respective I/O modules.

2.11 **Redundant / Non Redundant I/O**

I/O involved in close loops, interlocks etc. as identified in DCS/ PLC data sheets shall be connected to redundant I/O modules and I/Os for open loops shall be connected to redundant I/O modules. However for status and diagnostic signals such as Panel Temp etc shall be connected to non-redundant I/O module as per IO summary.

2.12 2oo3 signals or 1oo2 signals or 2oo2 signals shall be wired in separate junction boxes and connected to separate cards in different chassis in PLC.

2.13 System cabinet shall be controller wise. No two controller shall be installed in the same cabinet. Also marshalling cabinet of multiple controllers shall not be shared in same cabinet.

2.14 Spare management

Allocation of spares to be optimized such that more fully spare cards are available instead of many cards with few signals connected.

2.15 Vendor shall provide marshalling cabinet segregation philosophy for DCS, PLC& F&G as per clause 6.3.1.2 of Standard specification for DCS (6-52-0055). However the following shall also be considered in addition:

a) Separate for IS and Non-IS signals (if no. of signals are less, same shall be allowed in front and rear of same panel subject to approval from purchaser)

2.16 Each DCS/ PLC cabinets/console shall have static electricity discharge strip.

2.17 For repeat indication of analog input signals to field mounted remote output meters, the following philosophy to be followed:

a) For DCS conventional open loops, remote output meter shall be looped either through 3 way JB or via transmitter test terminals.

b) For DCS conventional close loop inputs and PLC interlock inputs, the repeat indication to remote output meter in field shall be through DCS AO card only.

2.18 Separate audible alarm for H/L and HH/LL value with different colour should be provided in DCS for ease of identification. Shelved alarm list should be separately identified in the system alarm page as part of diagnostics**.**

2.20 The time synchronization with existing external clock i.e. GPS shall be used .

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2.21 Vendor to note that loop wiring drawings shall be prepared by vendor during DCS engineering phase using **Intergraph Smart Plant Instrumentation (SPI) 2018latest version (Exact version shall be informed during detailed engineering)** and vendor shall handover the SPI database to Purchaser. The necessary inputs like Cable Schedule in Excel(.Xls) EIL standard format and SPI index database shall be provided by EIL to DCS vendor. Vendor's responsibility shall include the following:

a. Generation of cable schedules including MCC interconnection drawings in SPI.

b. Populate the same with required additional fields, such as marshalling panels, System interconnection details and I/O assignment.

c. Create Loop wiring drawings.

All relevant DCS & PLC SPI documents as mentioned above shall be provided by vendor in the above mentioned SPI format only. Also, vendor shall provide SPI generated documents/reports in PDF format. These documents shall form a part of DON documentation.

2.22 Count is used in sizing like server sizing, analog tags out of total serial tags in IO summary shall be considered proportional to the total group IO count in IO summary and further data points for each type of tags as defined in Standard Specification for DCS 6-52-0055.

2.23 **SPARE ADJUSTMENT**

The system sizing and design shall be carried out based on the I/O summary table given in the MR, in general. At any stage of the project, if IOs are found to have actual requirement less than the provision given in the subsystem wise I/O summary table, the same shall be considered for adjustment within the subsystem and Card and marshalling level for which the actual requirements exceed the provision given, and shall be with the approval of the Purchaser. The above adjustment is for I/O and auxiliary items only. Any changes with respect to wiring, cabinets, system sizing etc. shall be considered by vendor without any

implication. No change in system size shall be considered as long as the overall I/O including installed spares do not increase for the complete plant.

2.24 FOREIGN DEVICE INTERFACE SUB-SYSTEM

2.24.1 Vendor shall be responsible for providing serial link for all the foreign devices as per System Configuration and I/O summary. The details of some of these are provided below. Vendor to ensure that there should not be any operational disturbance in case of failure of serial link communication. Necessary hardwired instrumentation as required for this purpose of smooth interfacing with foreign devices to be selected by vendor as part of detail engineering. Where ever dedicated PLC is considered for packages as per I/O summary, all the signals shall be mapped to DCS with dedicated graphics by vendor.

a) DG Fire Alarm Panel in substation (To be interfaced with F&G PLC)

Serial link (dual redundant) for substation located DGFAP with MODBUS communication protocol having TCI/IP port shall be provided with transfer of data from DGFAP to F&G PLC for the Fire related signals. Necessary Fibre optic cables and convertors, both at the CR end as well as the substation end shall be in the scope of the Vendor.

2.24.2 Refer I/O summary Table and corresponding System Configuration for detailed connectivity. The type of signals referred herein is the designed specifications. The Vendor shall be responsible to interface the foreign device in case serial signal specifications are other than those specified herein, which will be confirmed during detailed engineering.

2.24.3 Wherever serial interface shall be through controller & data acquisition subsystem / processor subsystem, the no. of serial links per serial interface module shall be restricted to 4 subject to meeting loading criteria.

2.24.4 All the serial interface points coming from each foreign device shall be interfaced, displayed and annunciated in DCS.

2.24.5 Final allocation of each serial interface link to the designated controller and data acquisition sub system within each the unit shall be decided during detail engineering.

2.24.6 The scope of supply of the serial link cables for the various foreign device interfaces shall be as given elsewhere in Section-V of this requisition. Vendor shall note the following in this regard:

2.25 HARDWIRED CONSOLE LAYOUT (HWC)

2.25.1 Existing Hardware console shall be used to accommodate the additional signals as per IO summary. The detailed layout for Hardwired console (HWC) shall be worked out during detailed engineering by vendor. The layout for all hardwired consoles shall be reviewed by the purchaser.

2.25.2 Annunciator shall be powered using 110VAC UPS power supply.

2.26 FREE ISSUE INSTRUMENT/ EQUIPMENT DETAILS

2.26.1 Vendor shall supply the consoles and install the following Purchaser's items therein which will be over and above the requirements specified for the vendor's own systems:

S no	Unit Description	Console requirement for purchaser supplied item (s)	Console/ HWC	Location
1.	Offsite Tankage area	TFMS System CCTV System	1Nos 1 Nos	Existing DDCS-III Control room.

Note-1: The installation of the Purchaser supplied items and its accessories like converters, network switch, power supply modules etc. in the vendor's Consoles is also in the scope of the vendor.

Note-2: Supply, laying, glanding, feruling and termination at both ends of power supply cables from the vendor's PDB in the Rack Room to the Purchaser's free issue items mounted in these Consoles is also in the scope of the vendor.

2.26.2 Loop checking for Package PLCs/ other system, Loop checking for these items listed unit wise in I/O Summary of Section V of this Requisition shall also be in the scope of the Vendor in co-ordination with the other's field contractor.

2.27 MULTI CABLE TRANSIT (MCT)

2.27.1 Cable entry into the SRR/CR shall be through Multi Cable Transit (MCT) blocks. Vendor's scope of supply shall include the MCT blocks and frames at CR/SRR as below:-

Sr.No	MCT Type	Qty	Location
1	8+8X10	2	DDCS-III control room.

2.27.2 The MCT blocks and frames shall meet the following requirements.

a) The MCT frames shall be of standard RGB type and of galvanized steel construction as a minimum including frames, stay plates, wedges bolts etc. The MCT block shall be provided with centre core with adjustable OD with peeling off arrangement. Refer Annexure-1 for MCT specification.

b) The size of the cable blocks shall be decided by vendor based on the final cable schedules furnished during detailed engineering.

c) The MCT shall be installed as per the recommended practice of supplier. No spare space shall be left uncovered in the frame. The same shall be provided with MCT block with secured center core with adjustable OD with peeling off arrangement. Proper sealing arrangement shall be made by vendor between MCT outer frame and cut out wall.

d) The size and quantity of these installed spare blocks on MCT shall be proportional to the blocks used for cables.

e) Purchaser shall provide the MCT cut out opening sizes in the wall of the CR. Any modification required in the MCT openings due to the MCT frames supplied by the DCS vendor including proper sealing of the MCT frames with the building walls shall be in the scope of the DCS vendor.

f) Vendor shall dispatch the MCT frames at site at an earlier date before the system delivery, so that the same can be installed along with civil activity of the buildings. The date shall be intimated during detailed engineering.

g) MCT Sizing: MCTs shall be sized considering 20% installed spares for each cable size/ O.D. In addition to installed spares contractor shall also provide 20% spare insert blocks in each cable size/ O.D as loose supply.

2.28 EARTHING REQUIREMENT

2.28.1 Dedicated redundant two earth pits (minimum) shall be provided by purchaser for system earth (less than 1 ohm resistance) as per Part-I, clause 6.4 of Standard Specification for DCS (6-52-0055) for DCS and ESD/F&G Earthing pertaining to each CRs. These redundant System earths shall be further connected by the vendor to the Electrical Protective Earth system (less than 5 ohm) through Surge Isolation and Protection devices provided by the vendor as per clause 6.4 of Standard Specification for DCS (6-52-0055).

2.28.2 Supply of grounding cables and other related accessories required for system earth and Electrical earth and installation shall also be in the scope of work of DCS vendor up to earth bus bars below false flooring in the rack room of CR and SRR. Supply and Installation of

earth bus bars and further cabling including earth pits for system and electrical earth shall be by Purchaser.

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2.28.3 Connectivity of Cabinet metallic frames and SPDs (where required) to Protective Electrical Earth System as per clause 6.4 of Standard Specification for DCS (6-52- 0055)is also in the scope of the vendor including supply and laying of all related cables and accessories.

2.28.4 Vendor to refer M/s IOCL's Report of Reliability Improvements Volume 1 enclosed in Section-IV of the MR and also comply with the requirements given in Part-C Chapter-15 (Instrument Earthing System).

2.28.5 **CLIENT SPECIFIC REQUIREMENTS FOR EARTHING;**

a) Each panel, cabinet, console and other equipment in control room shall be provided with an earthing lug. All these lugs shall be properly secured to the AC mains earthing bus.

b) Separate earth pits with redundant earth bus shall be provided for the following:
1. Panel earth / Protective Earth / Electrical Earth
2. System Earth / Signal earth / Clean Earth

c) Minimum two earth pits shall be connected to form a grid. Grid earth resistance shall be <1 Ω for
system earth and <5 Ω for panel earth.

d) All circuit grounds of electronic instruments, shields and drain wires of signal cables shall be connected to instrument ground bus which is electrically isolated from the AC mains earthing bus. This bus shall be typically 25mm wide and 6 mm thick of copper.

e) The instrument ground bus is connected to independent instrument system ground buses through insulated wires.

f) The earthing cables from the earth-pit to the respective systems shall be insulated and use of bare cable / strips shall be avoided. Such cable shall be laid away from power cables etc.

g) Separate earth-pit networks is desirable for various instrumentation sub-systems like DCS / PLC earth, cable-screen earth, chassis earth, power earth etc. so that the problem in one system is not affecting the other system

2.29 The procedure for communication between DCS vendor, EIL & Owner shall be as per agreed procedure during detail engineering. The Purchaser/EIL shall participate in the following areas of system engineering:

Kick off Meeting (KOM), System definition Meeting, Software Definition Meeting & other Engineering review meeting.

Review of system sub vendor drawings / documents.

Factory acceptance test at sub vendor works for bought out items & FAT for DCS/PLC.

Loop Checking / testing & commissioning.

The Project schedule (mutually agreed by EIL/OWNER`& DCS vendor) shall be made during KOM for achieving the various milestones.

Any meetings considered necessary by Owner/EIL in order to achieve the Project schedule with DCS vendor shall be considered by vendor at discretion of Owner / EIL.

2.30 **PANELS/CABINET WIRING/TERMINATION**

a) The panels/ Cabinets wiring/ termination shall follow the requirement given Part-I, section 6.3 of Standard Specification for DCS (6-52-0055).

b) The ferruling philosophy/type shall be cross ferruling in general and will be finalised during detail engineering based on overall philosophy for the refinery. Ferrules used

shall be single sleeve with source destination type. Cross ferruling philosophy shall be followed for wiring including MCC interface cabling to DCS / PLC systems. Cross Ferruling (with identification tag plates) shall be applicable to all system cables (Communication bus, Controller to IO Cards etc.) also.

c) Cabinet lighting shall be 240 V AC non-UPS only and the lamps shall be white threaded type. One no. additional socket for 240 V AC shall be provided in each cabinet for use of other testing devices.

d) In all analog marshalling cabinets, provision shall be kept for mounting hand held configurator/ fieldbus tester for smart/fieldbus transmitter/multimeter.

e) Size of all power supply cables specially the cables within the panel must be properly selected with respect to load.

f) Inter panel wiring of input/output parameter are to be avoided to the maximum extent possible by suitable configuration of I/O to the system.

g) All cable glands shall be minimum SS material and they shall be of double compression type suitable for armoured cables.

2.31 Vendor to ensure that all the graphics of each Operator Console Group shall be made available in all the other Operator Console Groups / Workstations of same network group as per system architecture meeting the requirement of Clause no. 5.4.2.9 of Standard Specification for DCS (6-52-0055).

2.32 **MISCELLANEOUS**

2.32.1 Only structural frames shall be provided by Purchaser inside the false flooring /RCC trench for mounting the vendor's cabinets in Existing DDCS -IIIc control room Rack room area as per layout drawings attached in Section –V. Fabrication of Channel base frames for the cabinets, installation, bolting and fixing of the cabinets along with channel base frames with the Structural frames of the rack rooms and modification of finished floor in CRs shall be under DCS vendor's scope. Modification if required for structural frames shall be in vendor's scope. However, any spare cable entry and blank spaces left in these walls after installation and commissioning of the cabinets shall be sealed by the DCS vendor.

2.32.2 Any other civil work necessary with respect to fixing and finishing for cable entry, any fixing & finishing required for structural fixing, floor finishing, etc shall be taken care of by the vendor.

2.32.3 Removal, modification and refixing of false floor tiles & chequered plates as applicable and any addition structural support, if required, for false flooring shall also be provided by vendor.

2.32.4 Installation of all purchaser supplied equipment and free issued equipment's/items including cabinets, racks, consoles, panels etc. is in vendor's scope

2.32.5 Vendor shall provide all necessary cable trays inside the rack room for laying of cables below the false flooring / trenches in Existing DDCS -III control room and EPCC-11 Control room as per the layouts attached in this requisition, from the MCT up to the DDCS-III control room mounted equipment's including interconnecting cabling between the various vendor's supplied as well as owner's supplied equipment's within the control room .Vendor to note that cable trays (open trays (perforated /ladder) below the false floor in rack room of control room shall be considered for routing of field cables inside control room including power cables. Covered trays shall be provided by the vendor for all system and special cables. Perforated trays shall be provided by the vendor for all hardwire and power cables.

2.32.6 All cable trays shall be hot dip galvanized steel. The cable trays shall be made in standard lengths (section) of 3000mm and clear width of trays shall be 60mm, 150mm, 300mm.Tray thickness shall be minimum 2.5mm, height 20 to 50mm depending of width of the cable

tray. Each individual cable routed through trays must be clamped or tied using SS wires. The overall clamping shall be with aluminium clamp instead of tying with cable armour. Nuts/Bolts for cable tray fixing shall be SS. Perforation in the cable trays shall be provided at regular intervals for clamping of cables from cable trays.

The construction of cable trays shall be such as to facilitate easy handling, assembly and installation at site. The workmanship shall be such as to ensure easy laying of cables without causing damage of cables. The connections between two sections of cable trays shall be done by bolting only. Connector plates shall be designed with sufficient strength without derating the load carrying capacity of the tray. The side rails for each section of trays shall have holes on each end for fixing the connector plates. The trays for laying of system cables, serial link, prefab cables, network cables, special cables and fibre optic cables shall be covered type.

2.32.7 Cabling Philosophy inside Control rooms:

The cables shall be segregated and routed inside rack rooms of Existing DDCS-III Control room below false flooring immediately after entry into control room MCT. Separate routing of following type of cables shall be planned within control room/rack room to ensure ease of cable installation and to prevent the interference among the cables:-

- Analog 4-20mA cables
- RTD cables
- Contact/alarm cables
- Shutdown cables (for solenoid valves)
- Power cables
- System communication cables

All trays shall be properly tagged and clamped.

Separation with electrical cables shall be maintained as per API guidelines.

Vendor shall ensure the cabling philosophy inside DDCS-III Control room Rack room area and Console area of existing EPCC-11 control room and same shall be the sole responsibility of the vendor inside these rooms. Laying of all cables within these rooms shall be the sole responsibility of the vendor. This philosophy shall apply to all field cables entering the room through MCT also.

2.32.8 Cable entry in control room panels shall be via MCT. Gland plates in all panels shall be pre fitted with MCT from FAT floor, so that cutting of gland plates is not required at site.

2.32.9 The DCS and PLC cards/ modules in the CR shall be suitable for the environmental conditions specified in the “Standard Specification for DCS doc. No. 6-52-0055) and any necessary coating, if required on the cards / modules for smooth and trouble free operation of the same, shall be provided by the vendor.

2.32.10 Cable entry in control room panels shall be via MCT. Gland plates in all panels shall be pre fitted with MCT from FAT floor, so that cutting of gland plates is not required at site.

2.32.11 Vendor to refer M/s IOCL’s Report of Reliability Improvements Volume 1 enclosed in Section-IV of the MR and also comply with the requirements given in Part-C Chapter-14(Control Room Ambience) applicable as per vendor scope.

2.32.12 Vendor to refer M/s IOCL’s Report of Reliability Improvements Volume 1 enclosed in Section-IV of the MR and also comply with the requirements given in Part-C Addendum Chapter-21 (DCS).

3.0 FACTORY ACCEPTANCE TEST AND SITE ACCEPTANCE TEST:

3.1 Factory acceptance test shall be as per Part-II of the Standard Specification for DCS (6-52-0055) with the following additions for FF networks.

3.2 Vendor shall submit type test certificate for Heat soak test from their OEM for ascertaining the Performance of the DCS, PLC and associated sub systems under HVAC failure conditions.

3.3 DCS Vendor shall develop a separate written test plan and test procedure for the integrated control system

4.0 SPARES

4.1 **Mandatory Spares:**

Vendor shall provide Mandatory Spares as per Part-I, clause 3.1.1 of Standard specification for DCS (6-52-0055).

Refer to the clause 3.1.1.3 (a) of Part-I of Standard specification for DCS(6-52-0055).

4.1.1 Predefined mandatory spare:

Vendor shall provide predefined mandatory spares for DCS, PLC& related sub-systems for each subsystem as indicated in system configuration diagrams and I/O summary table of this MR as per clause 3.1.1.5 of Standard specification for DCS (6-52-0055) and as per Mandatory Spare Part Document No. B568-304-YE-SP-1509. The predefined mandatory spares are in addition to20% installed spares. The spares shall be calculated after taking into account the installed spares.

(For pre-defined mandatory spare, any item that is appearing in both Mandatory Spare Part Document and Part-I, clause 3.1.1.5 of Standard specification for DCS (6-52-0055), the higher count shall be provided by vendor).

The price for the mandatory spares shall be included in the base lump sum price of the M.R.

Mandatory spares as mentioned above and installed engineering spares and spare space as per clause no. 3.1.1 of Standard Specification for DCS (6-52-0055)and note 2.f of each I/O summary document shall be provided over and above the I/O count furnished in each of the I/O Summary tables.

Vendor shall furnish part number during detail engineering for all spares for SAP codification.

4.2 **Operation and Maintenance Spares:**

Vendor shall separately quote for the 2-years of operation and maintenance spare for the total system as per clause no. 1.2.8.(a) of Standard Specification for DCS (6-52-0055). In addition vendor shall also include the following items in the two years spares list:

Fiber optic patch panel(LIU),Network switches, media converters, special system cable connectors, Batteries, special system cables like RS485/232/422 etc, end connectors, advance diagnostic module, power supply module, field barriers, terminators etc.

Vendor should mention the items make, model and Part No with unit price for each sub systems and its accessories.

5.0 SPECIAL REQUIREMENTS FOR DCS/PLC.

Vendor shall ensure and provide the following as part of the offered system:

5.1 All DCS and ESD I/O's shall be connected through barriers / relays / isolators only. 5% of ESD Analog & Digital Input barriers shall be with one input and two outputs. For analogue output barrier, LINE FAULT DETECTOR shall be provided.

5.2 `ESD relay shall be SIL 3 certified (Except for HT motor 110 VDC Contact). Minimum no. of contacts for SIL-3 relays shall be 2 nos. & for others 4 numbers, with freewheeling diodes.

5.3 DCS / ESD / LCP and Instrument panels lighting fixtures shall be LED type and shall provide illumination of 300-400 lux at all places and shall switch on and off on basis of sensor. Door limit switch shall not be provided.

5.4 ESD power supply module mounted on the processor / I/O racks shall also be SIL-3 certified as part of the TUV certification of the PLC system.

5.5 The 24 VDC Bulk Power shall be provided system cabinet and marshalling cabinet wise in parallel redundant configuration. Bulk Power Supply for Field Terminal assemblies shall be dedicated and shall not be shared with other requirements.

5.6 All Cabinets shall be with minimum four roof mounted fans, with roof vent to meeting IP44 requirement. Fan failure alarm and cabinet temperature monitoring shall be provided for all cabinets.

5.7 All NIS digital inputs and outputs to PLC shall be through isolation relays with LED indication. Fail safe SIL 3 approved relays according to IEC 61508 & IEC 61511with LED indication shall be used for all SIL3 NIS digital Output signals, except for MCC, indication/status lamps/switches on hardwired console and inter panel signals within Control Room

5.8 All interposing relays (excluding the inputs / outputs between PLC and Hardwired consoles and MCC) shall be SIL-3 certified with automatic proof testing. However, for barriers of PLC, both SIL-3 and SIL-2 certified barriers are acceptable (for SIL-3 loops, only SIL-3 barriers shall be provided).

5.9 Interposing relays for Package PLC shall be located in PLC panel only and not in IRP cabinet

6.0 COMMUNICATION SUBSYSTEM:

6.1 All communication cables, data highway cable routed in the field (i.e. between DDCS-III CR / Substation/ EPCC-11Control room) shall be via dual redundant armored Optical Fiber type cables (OFC). The fiber shall fulfil latest ITU-T Recommendation G-652D for Single Mode optical fiber.

6.2 The OFC shall be with two layers of corrugated steel tape (Electrolytically chrome plated low carbon steel) armoring for the same. The outer sheath shall be of HDPE. DCS Vendor shall provide specific converters wherever necessary for the same with patch panel, LIU structured cabling etc.

6.3 All fibers (including spare fibers) of a cable shall be terminated in LIU (Light interface unit) by pigtails. Subsequent connection shall be by patch chords. Supply of pigtail, FC - PC connectors, patch chord etc. shall be by DCS Vendor . Purchaser's OFC pigtails with PC type connectors (for connection to components not in DCS vendor's scope) shall be connected to the DCS vendor's LIU at both control room ie in DDCS-III Control room.

6.4 The data highway cable for the DCS between Existing DDCS-III control room and purchasers existing EPCC-11 Control room system shall have a fibre optic cable separate for each redundant data highway. Primary and secondary shall not be combined in the same cable.

6.5 DCS vendor shall decide the number of core fibres in each Optical Fibre cable keeping 20 core fibers for purchaser's use and overall 100% spare cores for future use. All fibre optical cables shall be rodent resistant and armoured type only. Connector /converters for these cables also shall be provided by the DCS vendor

7.0 Unit Rate:

7.1 Vendor shall furnish Unit Rates of each DCS / PLC / F&G Sub-systems items with its necessary hardware and software required as per MR for addition / deletion purpose which shall include the unit rates of the items as per Annexure-XII. Unit rates furnished by vendor shall be comprehensive i.e., shall include cost of supply (inclusive of all associated cables, I/O chassis, connectors and termination assemblies), engineering, software modification, software licenses (I/O), documentation, transportation, unloading, installation, termination, wiring & testing, pre-commissioning, commissioning, etc. Vendor shall also include the cost of items, which are not listed in annexure-XII but required as per vendor system design / standard, as part of respective main item listed in annexure-XII and insertion of any new items by vendor in annexure-XII (format for unit rate) shall not be allowed.

7.2 Unit rate for addition / deletion shall be same and separate rates for addition and deletion are not permitted.

7.3 However additional ordering as "change order", wherever required, shall be carried out based on actual approved BOM by Purchaser for hardware and software during detail engineering. Unit rates shall be considered for adjustment between the types of cards / items during "change order" review and processing ensuring there is no net reduction in original P.O value.

SECTION-IV
(MCT SPECIFICATION)

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
0	04.11.24	ISSUED with MR	BO	KKP	SM

The MCT blocks and frames shall meet the following requirements:

1. MCT Frames and stay plates shall be made from galvanized steel as a minimum; however SS316 in place of galvanized steel is also acceptable. Depth of frame shall be 60mm as a minimum. MCT frames shall be suitable for welded installation.

2. The MCT shall be provided complete with accessories like insert blocks, wedges, stay plates, end packing etc.

3. Insert blocks shall be adjustable diameter type with center core. Base material of insert blocks and wedges shall be EPDM rubber with halogen free and low smoke index-F1Classification as per NF-16-101 & NF16-102, Heat Radiation test in compliance with M2classification as a minimum, UV Ageing Test as per ISO 4892-2 and Oxygen Index Test as per ASTM D2863. The MCT blocks shall be Rodent resistant.

4. The MCT assembly shall be IP 68 as per IEC-60529 and shall be installed as per there commended practice of supplier. No spare space shall be left uncovered in the frame. Uncovered space in frames shall be provided with adjustable diameter insert blocks of corresponding sizes as required based on the MCT layout which shall be prepared by vendor based on the final cable schedule during detail engineering. Solid blocks shall not be used. Where MCT frame size is by vendor, Vendor shall size the MCT frames considering minimum 20% spare availability for future use.

5. In addition to the insert blocks used for filling up the installed MCT frame, vendor shall additionally supply 30% spare (rounded up to the next higher number) adjustable diameter insert blocks of each size & type as loose supply for each MCT frame.

6. Wedge shall be used to compress the modules in the frame. Design of wedge shall not require any special tools to install/uninstall.

7. All bolts shall be of Stainless Steel.

8. Stay plates shall be used for separating the module layers.

9. MCT shall have type test certificate for the following and submit the same along with offer as well as during inspection:-

   - Water tightness of 4 bar pressure

   - Gas tightness for 2.5 bar pressure

   - Blast resistant testing with blast load of minimum 6 psi for 100 millisecond duration or Blast resistant testing with blast load of minimum 20psi for 20millisecond duration.

   - Fire rating with 2 hours test for fire integrity and insulation as per EN-1366/ UL-1479.

   The above testing shall have been carried out with MCT frame of minimum size 6+6X2.

10. While preparing the MCT layout, vendor to ensure that power cables, non-IS cables, IS cables and FO/ serial link cables are suitably segregated.

11. Vendor shall dispatch the MCT frames at site at an earlier date as per the schedule agreed with the purchaser, so that the same can be installed during building construction.

12. Complete MCT assembly including MCT frames, blocks, wedges, stay plates etc. shall be manufactured and supplied from the factory location from where these components have been manufactured for type test as specified above.

SECTION-IV
(MANDATORY SPARE PART LIST)

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
0	04.11.24	ISSUED with MR	BO	KKP	SM

1.0 PURPOSE

1.1 Vendor shall provide mandatory spares for DCS, PLC & related sub-systems for each operational group of the refinery as indicated in system configuration diagram and I/O summary table of this MR.

ITEM	SPARE PART	QUANTITY REQUIRED
1	DCS , PLC and related sub-systems	The mandatory spares are in addition to 20% installed spares. Mandatory spares shall be calculated by vendor as per philosophy outlined below .The philosophy shall be applied after taking into account the installed spares.
A)	Modules	10% or minimum one(whichever is higher) of each hardware/module (including Controller card, IO card, Power supply card, communication cards , Field termination assemblies and any other cards/modules etc) of each type which are being used in DCS, ESD, PLC, F&G PLC,SOE, AIMS, IAMS, DON,UHN and other system oriented items .
	Marshalling	10 % or minimum one no. (whichever is higher) of all components of cabinets like Bulk power supplies (of each rating/make), Diode Oring units (of each rating/make), Auto transfer switches, barriers, signal converters, Trip amplifiers, auxiliary modules, relays, converters, annunciator cards, fuses, fused terminals, lamps/LEDs, Pushbuttons, selector switches etc. of each type.
	Prefab Cables	10% or minimum 2 nos.(whichever is higher) of Prefabricated cable Set with connecting plugs for each type and length. 10% or minimum 1(whichever is higher) length of Network/Communication/ Interface Cable e.g Cat 6 ethernet/ FO Patch Cord etc
	Converters and LIU	10 % or minimum 2 nos.(whichever is higher) of RS232/485 / TCP/IP converters, Fiber Optic converters etc
	External Peripherals	10 % or minimum 2 nos.(whichever is higher) of Cabinet Air Filter 100% 20 % or minimum 2 nos.(whichever is higher) of Cabinet Cooling Fans and Air Filter of each type
	Fuse, MCB, Relay	20% or minimum two nos.(whichever is higher) of each type of Fuses, MCBs, Auxiliary relays.
	Communication	10 % or minimum 1 no.(whichever is higher) of communication system components such as hubs, switches, routers, connectors etc
D)	Consumables	All types of Consumable including a) 20% or minimum two nos.(whichever is higher) of each
		type of Printer cartridges/ Ribbon for all type of printers, Blank DVD (RW), Other storage device as applicable b)Printer paper for each type of printer : 10 Rims Minimum
E)	MCT Block	10% of each type of MCT Block used.

F)	Panel mounted instruments	10% or minimum one (whichever is higher)of each instrument
G)	Annunciators	Power Supply Module 10% or minimum one(whichever is higher) each type
		Tone Generator Card 10% or minimum one(whichever is higher)of each type
		Flasher Module 10% or minimum one(whichever is higher)of each type
		I/O Module 10% or minimum one(whichever is higher) of each type - Lamps 10% - Fuses 1 dozen per Annunciator
		Hooter 10% or minimum one(whichever is higher)
H)	Automatic Transfer Switch	10% or minimum one (whichever is higher) for each type

Report on Reliability Improvement in Power & Utilities and Instrumentation System in IOCL Refineries

Vol.-I

इंडियनऑयल

Indian Oil

Revision 00 – Dec'05
Revision 01 – Mar'10
Revision 02 – Jul'18

Report on
Reliability Improvement
Power & Utilities
and
Instrumentation System
2018

Volume 1

Custodian
MAINTENANCE & INSPECTION DEPARTMENT,
REFINERIES DIVISION

IndianOil

FOREWORD

Reliability Task Force had been formulated in Dec.'05 and subsequently revisited in May'10 for analyzing the key issues on operational practices and to provide recommendations for enhancing reliability & safety in the operation of the existing electrical systems and instrumentation systems.

There is a need to revisit of the existing RTF recommendations for Identification of new technologies, developments, schemes, systems etc. which shall enhance the reliability. Maintenance & Inspection Department; Ref HQ has taken an initiative to update the existing RTF recommendations.

A group of experienced officers was formed to review the last revisited task force recommendations. This group thoroughly examined the new recommendations obtained from all refineries and recommended corrective actions & system improvement recommendations.

The group has also provided recommendations for Enhancement of monitoring system for Electrical and Instrumentation equipment and Identified the maintenance & testing practices/ techniques to be ensured during shutdown.

I am sure that this document will go a long way in improving the quality, reliability and safety of the Electrical and Instrumentation system.

(S.L Maurya)
Executive Director I/C (M&I)

Date : 6th July, 2018

IndianOil

PREFACE

Process interruptions on account of non-availability of the power supply and controls have always been an issue of prime concern for refineries due to safety, economic and environmental consequences.

Reducing unwarranted interruptions & ensuring better reliability is the key to achieving high operational availability in our refineries.

A task force had been constituted in the past for improving reliability. This task force had come out with its first recommendations in Dec.'05 which were subsequently revisited in May'10. Individual Refineries have carried out gap analysis with respect to these recommendations and have also taken steps for liquidation of identified gaps.

The task force had analyzed the past failures and suggested recommendations for preventing recurrence thus leading to minimization of similar failures and consequential losses. The recommendations have also been aimed at bringing high degree of reliability in P&U and Instrumentation systems.

With advancement of technology and availability of better condition monitoring tools there is further scope for reducing interruptions. Hence there was a need to further strengthen the recommendations for enhanced reliability. With this objective in mind an exercise for revisiting / strengthening of these recommendations was carried out.

During this process the recommendations have been revisited by the concerned officers of the Refineries in general and a select group of experienced persons in particular. This group has come out with some modifications in existing recommendations as well as some new recommendations for improving the reliability based upon new learnings and technological advancements.

It gives me immense pleasure in issuing this document which will help in improving effectiveness, reliability and safety of the electrical and instrumentation system.

(SS John)

Executive Director (M&I)

Date: 6th July 2018

INDEX

EXECUTIVE SUMMARY FOR RELIABILITY REVISIT

1.0 Introduction

The existing RTF Guidelines of P&U was prepared in 2005 & last reviewed in 2010. With change in technology & architecture of systems along with experience enrichment over the period, it was decided to review the existing RTF guidelines. Refineries were asked to provide feedback on the existing recommendations and also to submit new recommendations, if any.

The feedback received from the refineries was compiled and reviewed by a select group comprising of experienced officers of Refineries. The group comprised of the following participants:

A) P&U team members

1. Sh G D Parashar CGM(M&I), RHQ
2. Sh Mukul Agarwal GM (P&U,IT), JR
3. Sh A K Tiwari GM I/C (P&U, IT), PR
4. Sh Rahul Prashant GM (ES & Insp), PR
5. Sh Vikas Gupta GM(Projects), RHQ
6. Sh Ritesh Thapliyal DGM (Elect & Instt),HR
7. Sh Pawan Rawat DGM(P&U), MR
8. Sh Ojaswi Kumar CMNM (M&I), RHQ

B) Instrument Maint. team Members

1. Sh MM Chetri, CGM (P&U, Inst), BGR
2. Sh N Vinod, GM (P&U, Instt), PR
3. Sh Manish K Pandey, DGM (Inst), PNC
4. Sh Prateek Singh, CMNM (M&I), RHQ
5. Sh RN Charles Sargunaraj, CITM, MR
6. Sh HS Jhinkwan, SITM, JR

The teams were facilitated & guided by Shri S.L. Maurya ED I/C(M&I), RHQ & Shri Sandeep Sanjay John ED(M&I), RHQ.

2.0 Objective / Philosophy

The objective of the exercise for review reliability recommendations, to ensure sustenance of the reliability improvement process.

The philosophy adopted during the revisit is as under:

P&U

- Strengthening of systems / equipment health monitoring practices for identification of potential abnormalities.
- Review of schemes based on recent failure experiences.
- Strengthening of recommendations by adoption of new technologies for condition monitoring/ equipment testing.

Instrumentation

- Increasing the reliability of Petrochemical Instrumentation.
- Incorporating new recommendations based on recent failure experiences.
- Enhancing the monitoring of all system redundancies so that no system runs in a degraded mode.
- Review of recommendations to ensure 100% checking of all critical hardware during M&I shutdown, which cannot be made redundant or is not redundant due to any other constraint.

3.0 Approach adopted for the study

i. Considering all issues related to reliability, failure root cause, limitations, innovations, use of new technologies, etc., feedback on RTF guidelines from all refineries was obtained.

ii. Based on the data obtained from the refineries, the 2010 Revision-1 recommendations were reviewed & modified and addendum points were added in the parent chapters. Some new chapters were also added.

iii. Detailed deliberation was held with the experienced team on 25th - 26th April 2018 to ensure the technical suitability / applicability of the recommendations to our system.

4.0 Analysis of interruptions

The interruptions from Apr.'2015 have been analyzed along with the study of failure analysis and corrective measures undertaken against each failure. Although there has been a decline in the number of failures in the last three years, some of the failures were avoidable and attributed to non-implementation of the recommendations. There have been around 55 nos. of P&U failures and 56 nos. of Instrumentation failures in the last three years. Brief analysis of the failures is as following:

P&U Analysis

Sl. No.	Equipment / system	% contribution to failures
1.	Control & Protection system	27%
2.	Cable failures	20%
3.	SOP related	11%
4.	Equipment/ system health resulting in flashovers	22%
5.	STG/GT related	7%
6.	UPS	2%
7.	VFD	11%

The major observations on P&U failures are as under:

i. Inadequate testing and supervision during commissioning.

ii. Improper Substation ambience contributing to flashover.

iii. Cable and joints failures

iv. Gas turbine related problems.

v. Non adherence to systems and SOPs

vi. Cards failures and scheme related issues in VFD

Accordingly, recommendations have been given for enhancement of the system reliability, elimination of fault initiators to the extent possible for ensuring sustenance.

Instrumentation Analysis

Sl. No.	Inadequacy in	% contribution
1.	PLC	16%
2.	DCS	11%
3.	VMS	11%
4.	Control Valves	8%
5.	Barrier	8%
6.	Power Supply	8%
7.	SOV	8%
8.	Emergency Push Button/ Terminal Block	8%
9.	Standalone Controllers	8%
10.	Motor Purge System/Damper	8%
11.	Thermowell	3%
12.	Level Switch	3%

The major observations / contributing factors on Instrumentation failures are as under:

i. Obsolescence /Aging

ii. Improper Process Condition/ Environment.

iii. Poor Workmanship

iv. Non-compliance to RTF

v. Improper termination/ Wiring

Accordingly, recommendations have been given for enhancement of the system reliability.

The modified/added RTF recommendations are highlighted in blue colour. The list of recommendations which had modified/added in the recommendation had been attached as Annexure-1(P&U recommendations) & Annexure-2 (Instrument recommendations).

◀- Point with explanation at the end of the respective chapter.

Exhibit-1B

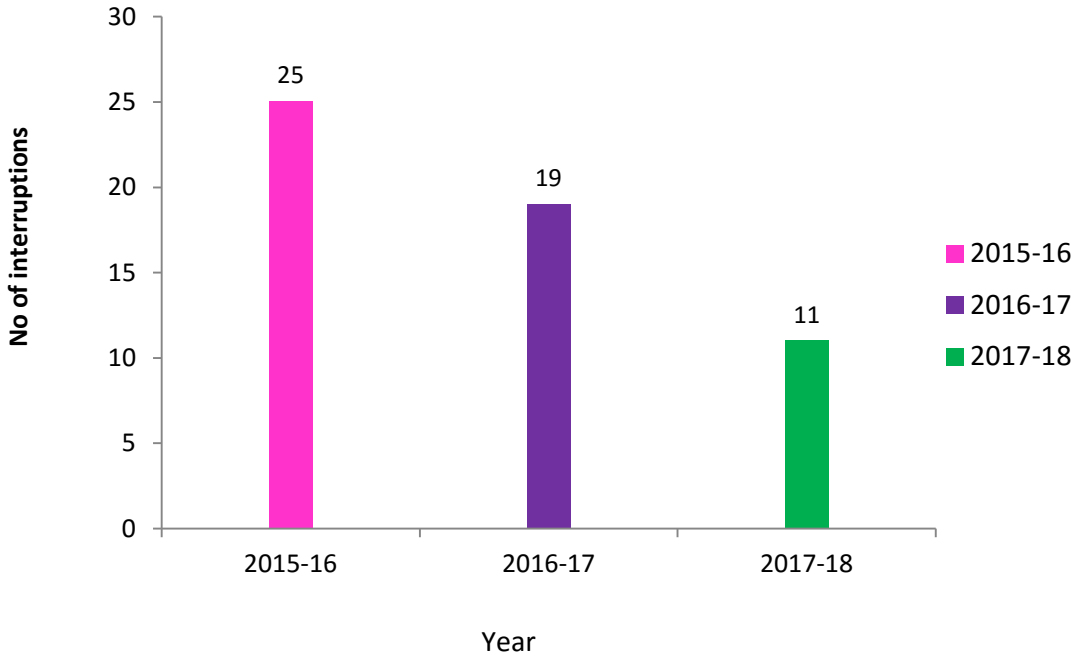
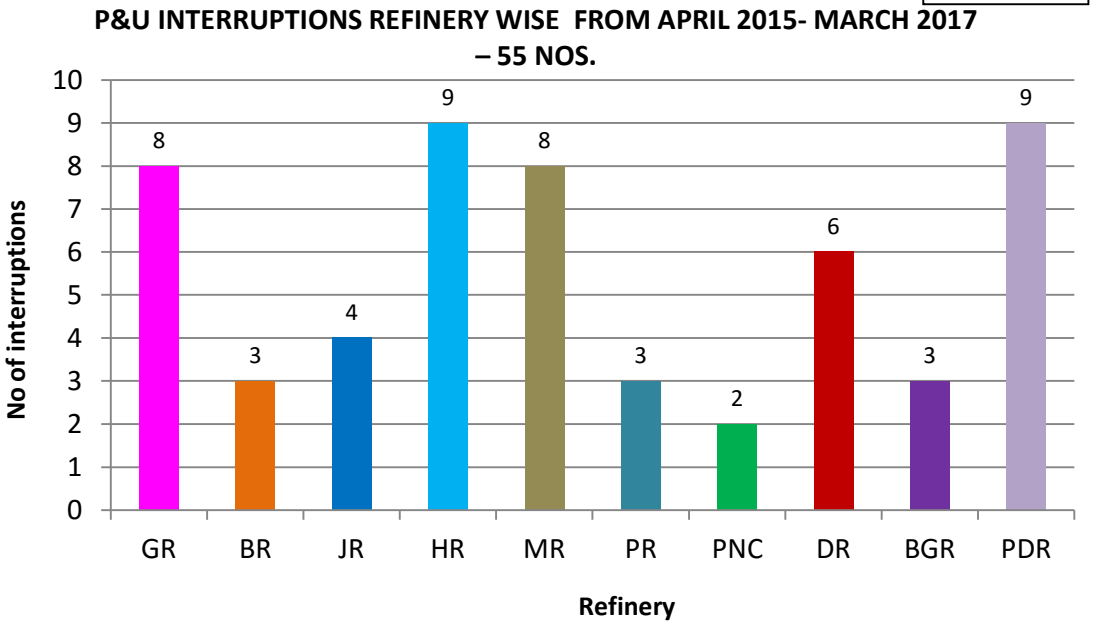
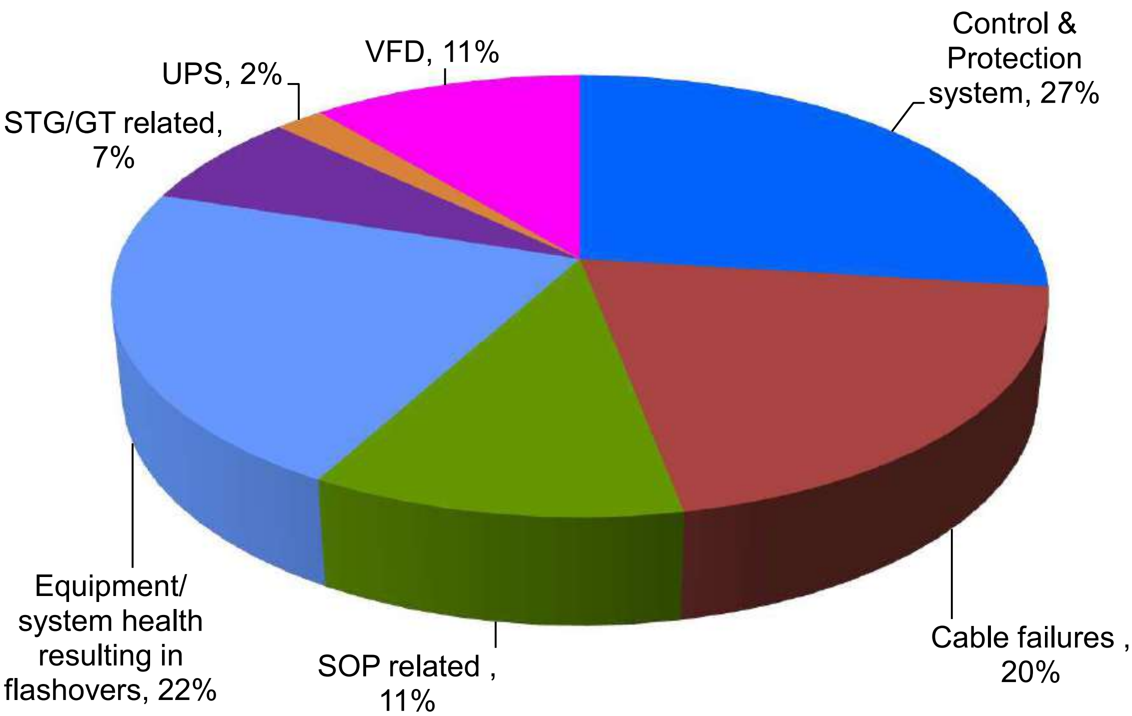


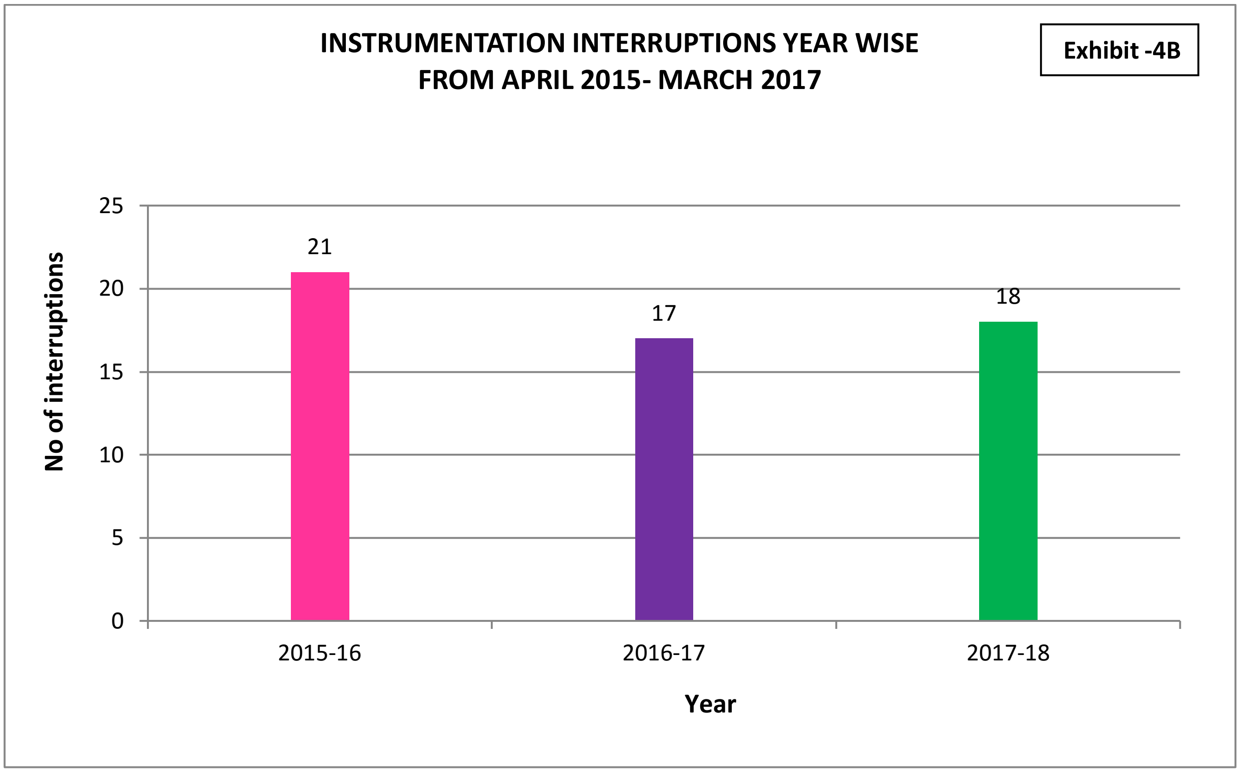
Exhibit-2B

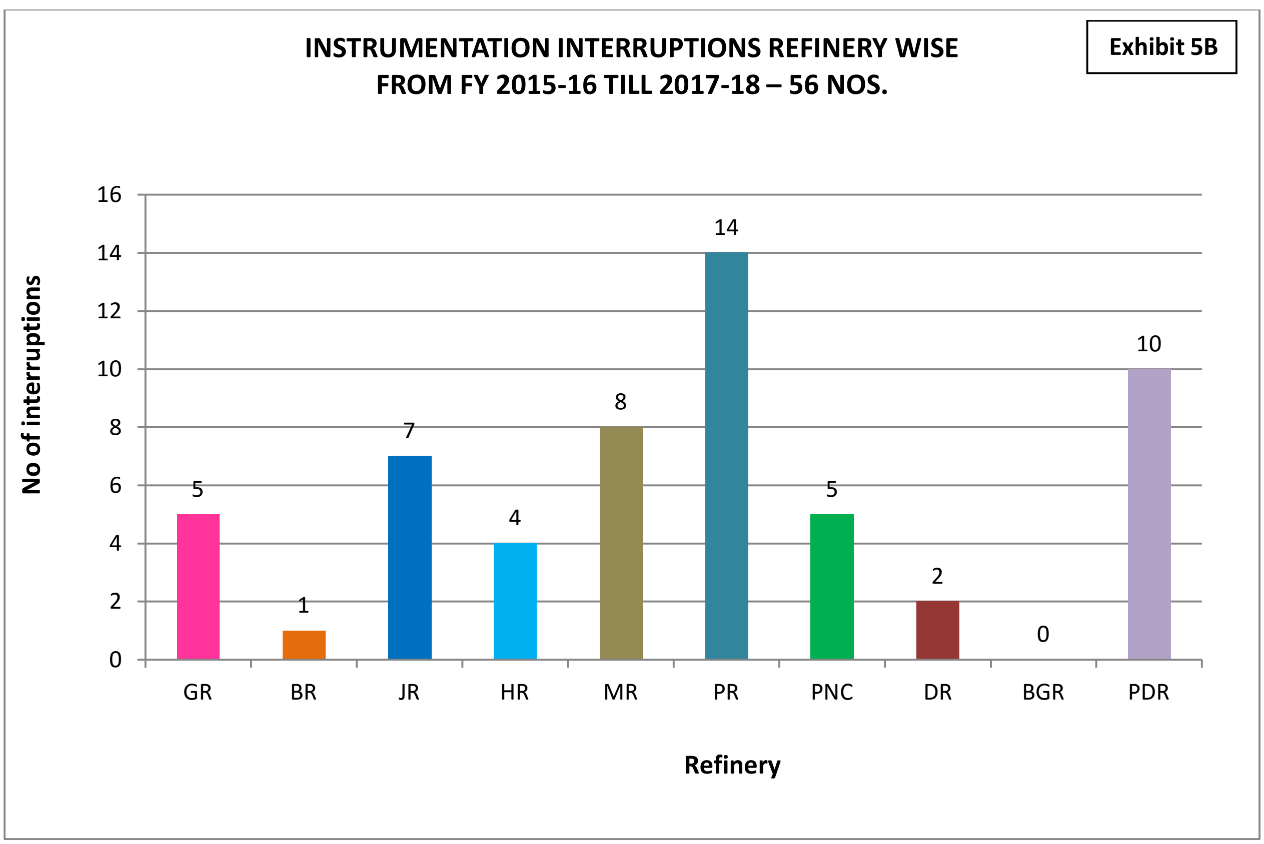


P&U INTERRUPTIONS SYSTEM WISE FROM APRIL 2015- MARCH 2017

Exhibit 3B

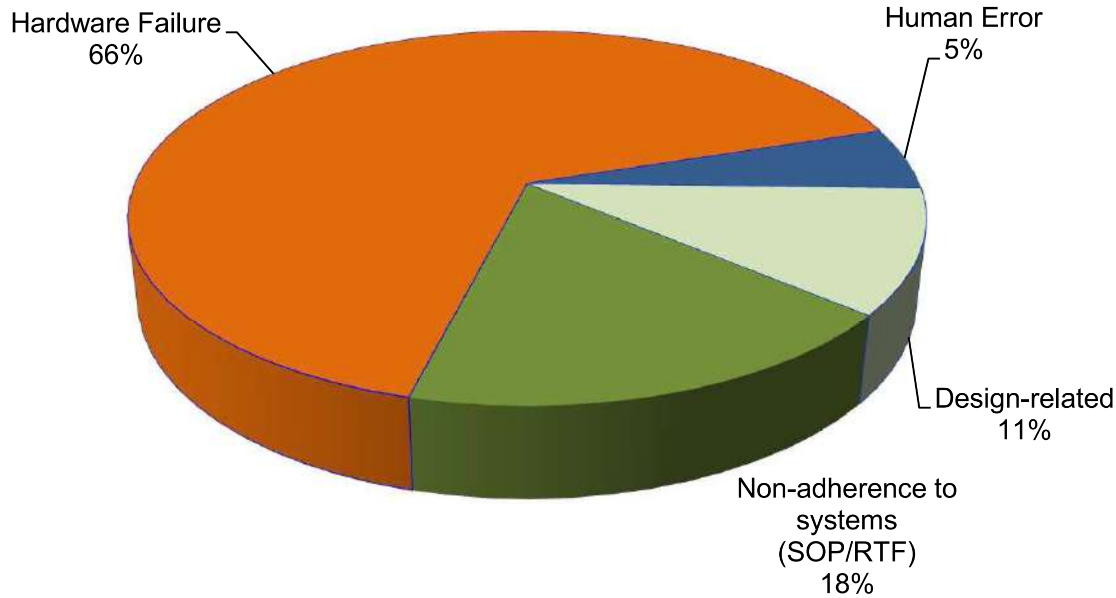



INSTRUMENTATION INTERRUPTIONS YEAR WISE
FROM APRIL 2015- MARCH 2017
Exhibit -4B
No of interruptions
25
20
15
10
5
0
21
17
18
2015-16
2016-17
2017-18
Year


INSTRUMENTATION INTERRUPTIONS REFINERY WISE
FROM FY 2015-16 TILL 2017-18 – 56 NOS.
Exhibit 5B
No of interruptions
16
14
12
10
8
6
4
2
0
5
1
7
4
8
14
5
2
0
10
GR
BR
JR
HR
MR
PR
PNC
DR
BGR
PDR
Refinery

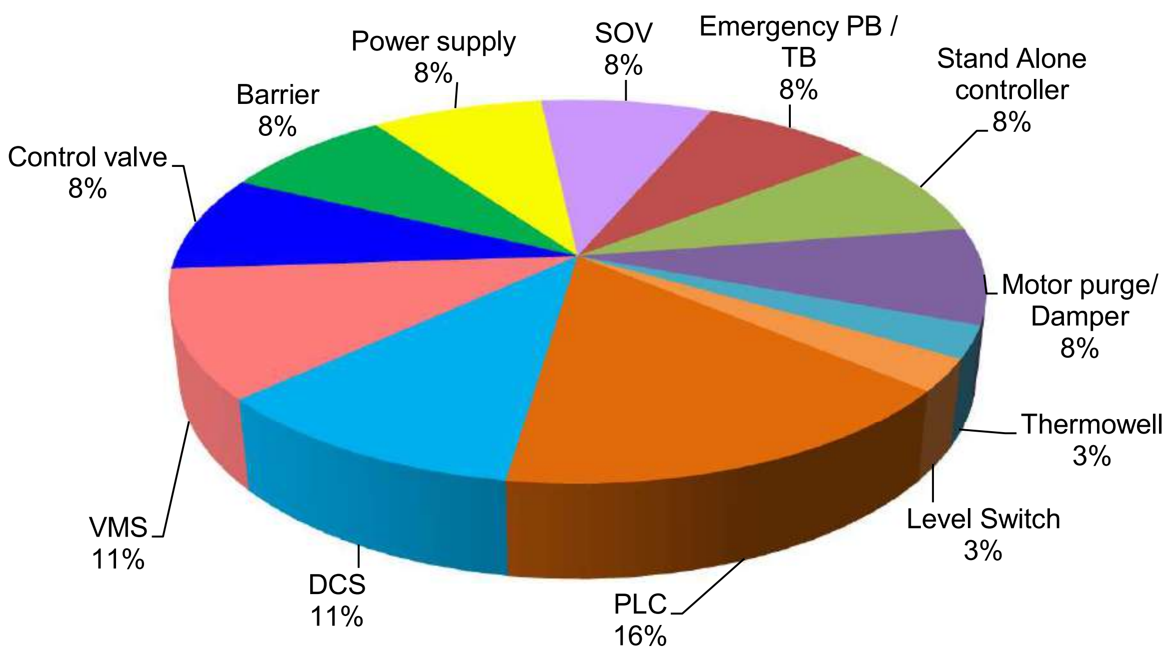
INSTRUMENTATION FAILURE ANALYSIS
(FROM APRIL 2015- MARCH 2017)

Exhibit-6B



INSTRUMENTATION FAILURE ANALYSIS -
HARDWARE FAILURE – CATEGORY (FROM APRIL 2015- MARCH 2017)

Exhibit-7B



Annexure-1

Revisited P&U recommendations summary

Chapter no.	Recommendations Modified	New recommendations Added	Recommendations Deleted
1.	1.2.4 1.3.4 1.3.12 1.5.18	1.1.13, 1.1.14 1.1.15 1.1.16 1.2.5 1.2.6 1.3.14 1.3.15	-
2.	2.3.19 2.3.22 2.3.40 2.3.48 2.5.6	2.1.10 2.1.11 2.3.18 2.3.27 2.3.54 2.3.55 2.5.16 2.5.17	-
3.	3.4.4 3.5.4	3.2.12 3.2.13 3.2.14 3.2.15	-
4.	4.5.3	4.2.17 4.2.18 4.2.19 4.5.7	-
5.	5.1.8	5.2.17 5.2.18	-

Chapter no.	Recommendations Modified	New recommendations Added	Recommendations Deleted
6.	6.16	6.22 6.23 6.24	-
7.	7.10	7.15 7.16 7.17 7.18	-
8.	8.1 8.14	8.21 8.22 8.23 8.24 8.25	-
9.	9.13	-	-
10.	-	10.17 10.18 10.19	-
AC1	-	1.26 1.27	-
AC2	-	2.7	-
AC3	-	-	-
AC4	-	-	-
AC5	-	5.5	-
AC6	-	-	-

Annexure 2

Revisited Instrumentation recommendations summary

Chapter no.	Recommendations Modified	New recommendations Added	Recommendations Deleted (S.No. as per old RTF)
11	11.9 11.12 11.13 11.14 11.16 11.20 11.21 11.24	11.29 11.30 11.31	-
12	12.4 12.7 12.9 12.15 12.17 12.24 12.25	12.26 12.27 12.28 12.29 12.30 12.31 12.32 12.33 12.34	-
13	13.3 13.8 13.9	-	13.8
14	14.3 14.5 14.6 14.7 14.8 14.9 14.11 14.17 14.23	-	14.18
15	15.3	15.7 15.8	-
16	-	-	-

Chapter no.	Recommendations Modified	New recommendations Added	Recommendations Deleted (S.No. as per old RTF)
17	17.1.1 17.1.3 17.1.4 17.5.1 17.5.2 17.5.4 17.5.8 17.5.12 17.5.13 17.5.14 17.5.20 17.5.23 17.5.24 17.5.26	17.5.30 to 17.5.42	17.1.2 17.5.13
18	18.1 18.2 18.4 18.6 18.8 18.9 18.11 18.16 18.17 18.19 18.21 18.23	-	18.15 18.21 18.22
20	20.1	-	-
21	-	New Chapter on DCS Added	-
22	-	New Chapter on Petrochemical Instrumentation Added	-

Part-A

OPERATING PHILOSOPHY
AND
SYSTEM DESIGN REQUIREMENTS

PART A

"Operating Philosophy for Power & Utilities Systems and System Design Requirements "

The power and Utilities systems have different configurations and operating philosophy in different units. The evaluation of various failure reports reveal that there is a major contribution of system configuration and operating practices in preventing the outages during crisis and thus providing reliable utilities to process units. An effort has been made below, to provide the refinery units with well established and internationally adopted systems in terms of configuration and operating philosophies for P&U operation. Following areas of Power and utilities, which need a broader focus in achieving the efficient and reliable plant operation have been considered.

1. Operation of Power & Steam Generation System
2. Electrical System Operation (Power plant and major secondary sub stations)
3. Power and Steam Load Shedding
4. Operation of balance of plants and auxiliaries in Power plant
5. Instrumentation system associated with P&U operation

The design aspects and recommended practices associated with reliability enhancement of these systems (and their sub systems) have been elaborated in detail in the part B of this document. This will provide the user a chapter wise consolidation of recommendations and convenience in future referring to the reliability related issues with a particular system/ sub system.

1. OPERATION OF POWER & STEAM GENERATION SYSTEM

Refinery power stations should be designed to supply 100% of plant electrical & steam loads in the islanded mode of operation. Some of the key aspects for reliable operation Power & Steam Generation System, which should be adhered for ensuring uninterrupted utilities to Process Units, are as under:

1.1 Number of Power & Steam generating units to be kept in operation should be based on:

- The generating units should meet the load requirement, after Automatic Load Shedding, when the single largest machine is out of service and the second largest single source has coincidently tripped or shut down due to unforeseen circumstances in line with API Standards & practices of multinational companies.
- The peak power & steam demand.
- Capacity of the installed power & steam generation units.
- System fault level (Limitations, if any, in running maximum number of units in parallel)
- Power and Steam Load shedding capabilities, in auto mode, under different contingencies.
- Some of the Indian Refineries have adopted practices such that none of their operating units are affected when one of the generating units is tripped (MRPL/ RIL)

1.2 The efforts should be made that the highest rating generating units of power & steam is available for operation for maximum duration by optimizing maintenance down time.

1.3 It is desirable to keep a contingency margin of 15% –20 % of the prevailing load as spinning reserve in power generation to take care of staring of large motors and other system disturbances, even if the largest machine is out of service. Similarly, a contingency margin of 20% –25 % of the prevailing steam load to be kept in the steam generators in operation. The available margin on the running boiler should be arrived after accounting for the internal consumption of the boilers.

1.4 To enhanced reliability, it is recommended to give preference to operate HRSG than the conventional boiler. This will help in quick recovery of system to cater to steam load when one of the steam generator trips. In case HRSG is running with partial load, it is desirable to run HRSG on minimum supplementary firing.

1.5 In case a Utility Boiler is kept in operation, it is desirable to keep maximum number of burners in service in Utility Boilers for quick loading in emergency situations.

2. ELECTRICAL SYSTEM OPERATION

The philosophy outlined hereunder is to ensure reliable and safe operation of the existing electrical systems, which have been designed based on standard design specifications. However, the statutory requirements/ regulations for the electrical system need to be strictly complied with.

The detailed recommendations on the design aspects and recommended practices associated with reliability enhancement of various sub systems of the Power network have been elaborated in detail in the Part B of this document, by bringing around focus on the following critical areas.

- HT System *(Primary & Secondary Sub stations)*
- HT Motor Feeders, Operation & Control of HT Motors
- LT Distribution System, Operation & Control of LT Motors.
- Bus Transfer Schemes *(HT and LT)*
- DC Systems *(Battery Charges and Battery Banks)*
- Un-Interrupted Power Supply Systems *(UPS)*
- Variable Speed Drives & Soft Starters
- Load Shedding Scheme *(Power and Steam)*
- Operational Checks and Maintenance Practices

However, the key issues on operational practices to provide enhanced reliability and safety in the operation of the existing electrical systems have been discussed below;

2.1 Bus Bar Configuration / Switchgear Requirements

2.1.1 It is desirable to have separate Generation Bus and Distribution buses in the Primary Sub Station of the power plant. This will provide operational flexibility and minimum disturbances to the running system, in case of faults and system troubles

2.1.2 In case generation bus is having bus coupler, the plant is to be operated keeping bus coupler OFF and selecting it in Auto mode. Similar care is to be taken for bus couplers in Distribution bus.

2.1.3 Out put of each Generator shall be connected in parallel to two identical generation buses (double bus bar arrangement) through breakers and synchronizing facility. Each bus shall be rated to carry 100% of plant loads continuously.

2.1.4 It is also desirable to have sectionalizing in Generation Buses with two or more sections to facilitate scheduled maintenance of generation bus bars without system shutdown. Sectionalizing circuit breakers to be used between each section of the same Generation Bus. The care to be taken that number of sections should not exceed the number of generators installed ion the bus.

2.1.5 The plants which are having common Generation cum distribution bus system, the bus philosophy and configuration of generators shall remain same as discussed above. However, it is desirable to have sectionalizing breaker between each generator.

2.1.6 The sectionalizing breaker, wherever provided in the generation bus / generation cum distribution bus, shall be with manual closing through check synchronization relay. In order to eliminate the complexity in relay coordination and spurious tripping, the sectionalizing breaker should have only bus differential protection with cross- over zones between two adjacent buses.

2.1.7 There can be more than one primary sub-station wherever expansion of the existing system is not feasible due to limitations of space / system parameters etc.

2.1.8 The distribution buses in the primary sub-station shall be fed from the main generation buses. Two adjacent distribution bus sections shall not be fed from same generation bus / two adjacent sections of the same generation bus.

2.1.9 Bus coupler with Auto- Manual transfer system upto PCC level shall be provided between two adjacent distribution buses with permanent paralleling feature unless there are limitations on fault levels. In case of manual transfer, the closing of bus coupler breaker shall be made through a check synchronization relay

2.1.10 Due to limitations of fault level, if momentary paralleling of incomers has been provided out in large areas of existing setup. Interruptions have taken place in the past due to human error. Therefore, it is preferable to use closing command in place of trip command while operating momentary paralleling schemes.

2.1.11 Radial feeders in the secondary sub station shall be fed from the distribution bus in the primary Sub station. It is to ensure that two radial feeders in same secondary substation are also not be fed from same generation bus and adjacent sections when viewed from the source end. (Refer Schematic Drawing No. – E05)

2.1.12 The radial feeders suppliying to plant loads shall have feeder differential (cable differential) protection and provision of inter tripping with upstream circuit breaker (Refer Schematic Drawing No. – E06)

2.1.13 It is desirable to have two incomer breakers and bus coupler with Auto- Manual transfer facility, irrespective of the rating of MCC of GTs and BOP of TPS

2.1.14 Incoming AC supply to Battery Chargers and UPS should be independent and should be so connected that their feeding generation level source should not same and to the extent possible not from adjacent sections also.

2.2 Protection, Control & Supervision

2.2.1 Each refinery shall have updated relay coordination based on the consolidated system study carried out for the entire connected electrical system. The system study should be revalidated with the new expansions / source augmentation

2.2.2 All HT switchgear (6.6 KV and above) must be provided with bus differential protection with cross over zones at Bus Couplers/ Emergency tie. All outgoing breakers shall be covered in the differential zone of protection.

In order to enable monitoring of spill currents and prevent spurious tripping, the bus differential relays (including that of Generators) shall be numerical type. It is desirable that spill current of all the three phases is continuously displayed on the relay front panel.

2.2.3 Overlapping of protected zones shall always be provided to ensure that no part of the switchgear is unprotected.

2.2.4 It is desirable to use Reed Switch type Bucholz Relays in place of Mercury Switch type relays in seismic prone area to improve the operational reliability of the secondary distribution system.

2.2.5 The control supply to protection relays shall be separate from the breaker control supply in the switchgear feeders where Numerical relays are used.

2.2.6 The control supply to Generation Bus and Distribution Bus in the primary substation shall be DC with redundancy (Refer Schematic Drawing No. – E05). Provision shall be made for monitoring the health of the control supply to each switchgear panel

2.2.7 Any interruption in the switchgear DC control Supply shall not lead to tripping of the circuit breakers. To take care of this the contacts used in the tripping circuits should not be taken from the multiplying DC contactors/ DC auxillary relays. (Not even from the multiplier contactor mounted in side the breaker)

2.2.8 All the critical alarms in the primary sub station (viz, Incomer/ Bus Coupler Trip / Critical PCC Status /Control Supply Status / UPS Status/ Battery Chargers Status/ Status Of Load Shedding etc) should be extended to the power plant control room, in addition to Generator related alarms.

2.3 Variable Speed Drives (VSD

The incidence of failure of VSDs, which are associated with the process unit operation, invariably lead to the tripping of the process unit. There are multi-dimensional factors such as switchgear room ambience, reliability of electronic components/ cards used in VSDs, limitation on the length of the power cable, control supply problems which lead to failure of VSDs. In spite of various corrective measures undertaken by the refineries to improve upon the performance of VSD, the incidents of failures of VSD still continues. This has been a major concern area in all the refinery units irrespective of the make of VSDs.

In order overcome this problem following philosophy may be adopted while opting for VSD in the critical process equipment.

2.3.1 It is advisable not to use VSD in the case when there is single equipment used for a particular service and tripping of which may result in tripping of process unit. Steam drives may be used for such cases.

2.3.2 In case the use of **VSD** in above case is unavoidable, there should be two equipment running in parallel sharing the process load and in the event of tripping of one the other running equipment should be able to immediately take up the full load.

2.3.3 If it not feasible to use two equipments running in parallel, then the single running equipment must be provided with redundant VSDs, both kept in service simultaneously as hot standby so that the failure on either do not stop the equipment. However, in such a case provision is to be made to isolate the defective VSD and carry out maintenance without stopping the equipment.

3. POWER AND STEAM LOAD SHEDDING

A sudden loss of generation in captive power plant may lead to collapse of the total system if demand is more than the generation and if corrective actions are not taken immediately for electrical system / steam generation. It may not be practicable to take corrective measures to prevent the total collapse with manual intervention and therefore automatic load shedding scheme is essential for power system operating in islanding mode. Following are some of the key issues for ensuring effectiveness of the load shedding scheme.

3.1.1 The Power Load Shedding Scheme shall always be kept in auto mode. Automatic Scheme will be designed / reengineered in manner that gap between load demand and generation is only shedded.

Manual group load shedding switches may also be kept at TPS control room, if need arises to operate manually. The steam load shedding should be preferably be operated in auto mode along with provision of manual mode operation.

3.1.2 For improved reliability, it is desirable that the logic/ECS based schemes to be backed up by under frequency-based schemes as any loss of generating source is always followed by decay in frequency.

3.1.3 The load shedding should take place in such away that the system voltage and the frequency remain within limits throughout the process of load shedding.

3.1.4 The priority and selection loads to be shed during load shedding should jointly be decided by **a multidisciplinary group and subsequent management approval**.

3.1.5 Critical loads like UPS, battery chargers, critical process units and critical process equipments shall not be covered under the load shedding scheme.

3.1.6 Operating practice and load shedding scheme must be reviewed/ upgraded whenever new units, boilers, TG, GT are added in the existing system.

3.1.7 All alarm/ annunciation/ indications related to **healthiness** and operation of load shedding should be made available in the power plant control room or nearly manned sub station. Indication of load shedding operated may also be provided in the Process control room. Systems should be developed for periodic checking the healthiness of load shedding scheme and the responsibility of the same should be attached to a responsible person.

4. Operation of Balance of Plants and Auxiliaries in Power Plant

4.1 Power plant Auxiliaries

Captive Power Plants in Refineries, which produce process steam and electricity, must be provided with highly reliable station auxiliaries. Some of the critical observations which are applicable to all the drives associated with the auxillary system of power plant such as FO Pumps, BFW Pumps, CW Pumps, Lube oil Pumps, DM Water Transfer pumps etc are given hereunder and should be adhered to for enhancing the reliability of the generation system.

4.1.1 As per international practices (recommended by API and major global refining companies) a combination of steam and electric (AC/DC) drives are to be used for critical auxiliaries for fuel, air water. It is desirable to adopt similar practices in our power plants and lube oil pumps of critical process equipments (viz. MAB, and compressors) unless they are provided with shaft driven MOP. However, if not already provided, the same may be considered during power plant expansion.

4.1.2 The number of pumps in operation shall be such that in the event of failure of one running pump the pressure must be automatically maintained.

4.1.3 In case DM Plant operation is on DCS/ PLC, the ON/OFF control of DM Transfer pump should also be available in Hard-Wired Mode. This will ensure DM water service to boilers in case of troubles in DCS/ PLC at DM Plant. Same may adopted for other auxillary systems at TPS (viz. FO, CW, Air compressors etc) where similar situation may arise and may lead to trouble in TPS operation.

Additionally, hard wired alarm for running low pressure / running pump trip should also be available, to initiate corrective manual intervention in case of PLC trouble in any sub system.

4.1.4 The system shall be designed to facilitate maintenance/ removal of pumps/ attend leakages without interruption of operations.

4.1.5 It is desirable *to have two headers for FO system for boilers with interconnection facility to facilitate emergency maintenance jobs without shut down of the FO system*

4.1.6 The pipeline network / headers/ heating equipment shall be such that leakage / outage of a particular section shall not affect the power plant operation.

4.1.7 The critical AC drives should have a reliable auto-changeover scheme. The auto-changeover shall be activated both by pressure interlock as well as contactor/ breaker interlock. **The low-pressure signal for auto-changeover shall be taken from a system of redundant low-pressure switches.**

4.1.8 The critical AC Drives (LT) should have a reliable re-acceleration scheme for ensuring reliability during voltage dips.

4.1.9 To the extent possible, the control supply for auto change over scheme should be either DC or UPS.

4.1.10 System should be developed for periodic checking of the healthiness of Auto changeover scheme. The observations in respect with shortcomings, if any, during actual operation of Auto changeover should form the part of failure analysis report.

4.1.11 Power distribution to the all the installed pumps/ compressors and their auxillary drives shall be such that they are fed from different switchgears which are finally connected to different

sections of HT primary and generation bus. (Refer Schematic Drawing No. – E07)

4.1.12 Availability of alarms, annunciation, indications on the following to be ensured in local as well as in the Power Plant control room:

- Status of Auto-mode selection of standby pump.
- Low pressure alarm.
- Auto-changeover alarm.
- Status of equipment running.
- Alarm on tripping of running equipment

4.2 PRDS

The PRDS should be capable of continuously supplying to 100% process steam requirement and shall be with redundancy feature.

4.3 Auxillary system for GT/ HRSG

4.3.1 For GTs operating on naphtha liquid fuel and having independent fuel forwarding skid with only one running pump suitable re-acceleration and auto-changeover interlock should be provided

In addition to above, the HSD fuel-forwarding pump shall be in continuous operation in recalculation mode for eventualities of failure of both the naphtha pumps.

4.3.2 For GT system alarm of tank level, offsite pump status etc. to be made available in the control room.

4.3.3 Provision of duplex HP filter should be made in the GT operating with liquid fuel, to avoid stoppage of the machine for filter replacement.

4.3.4 Provision of power sources from different sources / sub-station to be made for the following devices:

- GT jacket cooling fans (88- TK 1 and 2). {For frame-6 machines}
- Naphtha pumps.
- HSD pumps.

4.3.5 In certain installation dedicated DM water-cooling system (with pumps) is used for the atomizing air cooler. A separate service water line shall be laid up to the atomizing air cooler, with draining facility, to avoid interruption of GT in case of failure of the dedicated DM water pumps.

4.3.6 For multiple GT installation, separate earth-pit-network is recommended for individual GT. Effort should also be made for physical separation of the Mark –IV / Mark – V panels to maintain the integrity of the separate earth-pit networks. Thus the problem of one unit shall not affect in other units.

4.3.7 Care needs to be taken during re-filling operation of Hi-tech solution in the tank while GT is running on naphtha. It is experienced that the "LOW LEVEL SWITCH" of the Hi-tech tank gets actuated during manual re-filling operation and initiates a fuel change over. A longneck funnel shall be located, away from the level switch, in the vessel for periodic re-filling of the Hi-tech additive.

4.3.8 An additional facility may be provided to start jacket-cooling fans (88-TK1 & 2) of GT from their respective control room.

4.3.9 Inspection and replacement (if needed) of the fire detectors/cables during HGP.

4.3.10 UPS supply shall be provided for GT damper control system.

4.3.11 Swage lock / Parker make fittings shall be used for all tubing connections of Gas Turbine

5. INSTRUMENTATION SYSTEM

5.1 Instrumentation for monitoring and control must be optimized (minimized). Excess of instrumentation in a plant generates a potential source of interruption of plants.

5.2 Any parameter considered in tripping logics must be implemented through voting logic of 2-O-O-3, unless it is not practicable to implement.

5.3 Adequate redundancy and capacity shall be considered for instrumentation power distribution system.

5.4 Looping-in and looping-out of power for any critical instrumentation device should be avoided.

5.5 Separate Earth grid shall be provided for instrumentation earthing system. Dedicated earth-grid shall be provided for different instrumentation systems.

5.6 "Common mode failure" in any part of the instrumentation system shall be reduced / eliminated.

Chapter-1

GENERATORS AND GENERATOR AUXILIARY SYSTEM

Generators, in a Captive Power Plant, play a major role in providing uninterrupted, stable reliable power to the Process Units. The operation of generators is desired to have a very high degree of reliability. It is not desirable to have generator tripping on account of electrical faults taking place out side of its protection zone, system under voltages, loss of power supply to any of the auxiliaries supporting the generator operation etc.

In order to critically analyse and to discuss the reliability related issues on generator operation, the Generation System has been divided into following sub sections.

1. Generator and its excitation system/ PMG
2. Generator Bus Bars/ Bus Duct / Cables
3. AVR / DAVR
4. CTs/ PTs/ Lighting arrestors
5. Generator Protection and Control Supply
6. Operational Checks/ Plant monitoring

1A - RECOMMENDATIONS

Based on the failure analysis of the past incidents taken place in various refineries and the experience sharing with the experts / OEMs / plant operating personnel, given below are some of the best recommended practices which may be adopted by refineries in order to enhance the reliability of the Generating System. Detailed explanation to these recommendations marked as (◄) has been enclosed at Section 1B of this chapter.

1.1 Generator and its Excitation System/ PMG

1.1.1 In case of tripping of Gas turbine, it is desirable to trip the generator directly through Gas Turbine trip command instead of tripping the generator on reverse power protection. ◄

1.1.2 In GTG's, proper care to be taken to avoid GTG tripping while drawing out the Unit Master Trip Relay (86U) as generally "NC" contact of relay is used for turbine tripping. It is suggested either to use the "NO" contact of the 86U relay in Mark-IV/V, if feasible, for turbine tripping or provide a warning on the relay mentioning "Do Not Remove In Machine Running Condition". ◄

1.1.3 ***It is desirable that the provision of mechanical closing of generator breaker from the breaker front plate is properly covered to prevent accidental closing.***

1.1.4 For emergency tripping of generator, it is desirable to have two Emergency Push buttons (with a protective cover) in series at Generator Control Panel.

1.1.5 It is desirable to block the manual opening of the field breaker if either of both the generator breakers is ON.

1.1.6 It is desirable to provide a check synchronization relay contact in series with the "Auto Synchronizer" command for closing generator breaker. The Check synchronization relay should be of "SKE" type and not "SKD" type.

1.1.7 In case of Generator High Temperature trip, it is desirable to take the 100 deg C tripping contact in series with the 80deg. C alarm contact or incorporate the logic 2 out of 3 (2-o-o-3) of the temperature sensors.

1.1.8 In case the Generator High Temperature trip command has been routed through a Fire Alarm Panel, It is desirable to provide DC supply / UPS AC supply to Fire Alarm panel.

1.1.9 It is recommended to control the space heater supply through generator breaker contacts or an alarm " Space Heater' ON" may be wired up to the control room.

1.1.10 For the newly commissioned machines wherever overhang type PMG's are provided, It is desirable to check the healthiness of the PMG-Exciter coupling bolts & bushes at the earliest opportunity. The practice to be included in the standard shutdown job list.

1.1.11 In view of the frequent troubles with the field mounted stroboscope for monitoring the healthiness of exciter diodes. It is recommended to use portable hand held stroboscope gun, if applicable.

1.1.12 It is desirable to separately wire trip commands from the generator master relay and TNC switch to the breaker.

1.1.13 Humidity sensors shall be provided in Generator air cooler ducts with continuous monitoring with alarm facility where water air coolers used for generator cooling. In case of abnormality, appropriate action shall be initiated by SHIFT INCHARGE.

1.1.14 Direct Air cooled generators shall be preferred for new projects.

1.1.15 RF based Wireless Temperature monitoring with alarm shall be explored and provided in generator terminals and generator bus incomers for necessary action by Shift incharge.

1.1.16 Generators **shall be provided with online PD monitoring system with alarm (In new projects). In existing generators, on line PD measurement facility with alarm shall be explored & provided for necessary action by Shift Incharge.**

1.2 Generator output and Generator bus bars/ cables

1.2.1 It is desirable to have separate Generation Bus and Distribution buses in the Primary Sub Station of the power plant. (Refer Schematic Drawing No. 1C.1) ◄ ***(New Facilities/ Projects)***

1.2.2 For system reliability, It is not desirable to have interconnection (Bus coupler) between the two generation buses of double bus configuration, as any fault in the common zone will trip the connected generators. The interconnection breaker, if provided, should be kept 'OFF'. (Refer Schematic Drawing No. 1C.2) ◄ ***(New Facilities/ Projects)***

1.2.3 Other issues related with the configuration of the Generation Bus have been discussed in detail in Chapter -2 (HT Systems). The same may be adopted for generator related portion.

1.2.4 In case single core armoured cables are provided, only single earthing (preferably source side) of the cable end terminations shall be done with proper marking on panel.

Proper TREFOIL formation of the single core cables of the different phases is to be done by using non-magnetic clamps with transposing of the cable bunch at regular intervals.
Transposition of screen with armour (with proper insulation) of the single core cables along with provision of sheath voltage limiters is also to be done at cable straight through joints (if exists) to minimize armour potential/ sheath voltage in new projects. ◄

1.2.5 Double bus couplers in generation bus are to be provided to enable maintenance of bus coupler (for new projects).

1.2.6 Gas insulated switchgear (GIS) shall be considered for generation bus of 33KV voltage & above. (For new projects)

1.3 AVR / DAVR

1.3.1 It is to be ensured that AVR performance remain unaffected during the power system voltage dips. ◄

1.3.2 It is to ensure that limiter settings have been made as per generator capability with all the limiters in service. ◄

1.3.3 Proper sizing of the outgoing cable from AVR to exciter is to be ensured by considering the allowable voltage drop. ◄

1.3.4 It is recommended to incorporate a time delay of 2.5- 3.0 sec. in the DAVR's auto- manual changeover logic during under voltage condition.

For DAVRs having dual AUTO channels, 100ms time delay may be provided for AUTO to AUTO changeover.◄

1.3.5 Alarm for AVR internal power supply failure is to be provided at manned location & healthiness of the supplies to be ensured before synchronization. ◄

1.3.6 Generator should be provided with instantaneous trip in case of AVR stage–3 faults (AVR Trip condition). ◄

1.3.7 It is to ensure that proper settings of field forcing limiter in AVR are provided to boost the excitation during voltage dip conditions for maximum duration depending upon machine capability. ◄

1.3.8 It is recommended to provide clear instructions regarding resetting procedure of DAVR alarms on the DAVR panel. ◄

Suitable printed inscription / sticker may also be provided on critical reset push buttons by indicating " Do Not reset- Connected to trip." to prevent human error during resetting the alarms on AVR/ DVAVR. ◄

1.3.9 In order to ensure proper dynamic response of AVR / DAVR, it is desirable to perform step test (dynamic tests) of the AVR as per the instructions / procedure given by the OEM during machine M&I. ◄

1.3.10 In order to facilitate AVR trouble shooting, it is recommended to maintain record of AVR test point values documented at various loads conditions e.g. 25%, 50%, 75% & 100% as a ready reference. ◄

1.3.11 In order to prevent tripping of AVR on AVR PT fuse failure, it is to be ensured that the scheme for "AVR changeover from Auto to manual mode on PT fuse failure" is in place. ◄

1.3.12 **Provision of "Dual Auto channel with manual channel" shall be kept for new projects. (New Procurement / Projects)◄**

1.3.13 It desirable to use harmonic suppression filters in the PT input circuits to take care the harmonics in the power supply as recommended by BHEL

1.3.14 Redundant power supply to PLC cards of DAVR from reliable 110V DC/110V AC (UPS) to be provided.

1.3.15 Power system stabiliser (PSS) function in DAVR wherever provided is to be kept disable for islanded mode of operation of power plant.

1.4 CTs/ PTs/ LIGHTING ARRESTORS

1.4.1 It is recommended to have window type CT's in Generator bus duct (phase & neutral side up to switchgear to avoid any possibility of CT insulation failure/ bursting due to heating. It is to be ensured that the PD value of the CT's shall be less than 20 pc during procurement ***(New Facilities/ Projects)***

1.4.2 In order to prevent tripping of generator due to flashover in the LA / PT/ NGR panel / HT Chamber because of faults in non-essential equipments e.g. light fittings etc. installed at these locations, it is recommended to remove such equipments from these panels.

1.4.3 Equipotential wire of the window type CT's installed in generator bus duct are to be examined for its dressing and extra length of the wire needs to be cut to avoid possibility of flashover with the adjacent buses of the other phases)

1.5 GENERATOR PROTECTION AND CONTROL SUPPLY

1.5.1 It is essential to provide differential protection scheme for the complete Generator including Bus Duct, HT cables & generator breaker. The scheme shall have overlapping protection zone with the bus differential scheme at switchgear level. (Refer Schematic Drawing No. 1C.4)

1.5.2 It is desirable to use numerical relays in the Generator Differential protection with 3- phase online monitoring of spill current otherwise periodic spill current measurement of differential relays to be done.

1.5.3 The HV cable differential protection shall be connected to the Unit Master trip Relay (86U), if provided separately.

1.5.4 It is desirable to provide separate back up over current and earth fault protections for individual generator breaker to have better coordination. (Refer Schematic Drawing No. 1C.5)

1.5.5 The under voltage tripping of generator need to be judiciously reviewed by units based on the under voltage

coordination with downstream incomers and maximum time allowed for the re-acceleration of motors.

1.5.6 In Brushless excitation systems provided with insulation resistance measurement type Rotor Earth relay, It is desirable that schemes provided with periodic detection facilities to be converted to continuous detection type of schemes. To prevent spurious tripping of the Rotor Earth fault protection, it is desirable to provide a suitable time delay in the alarm & tripping.

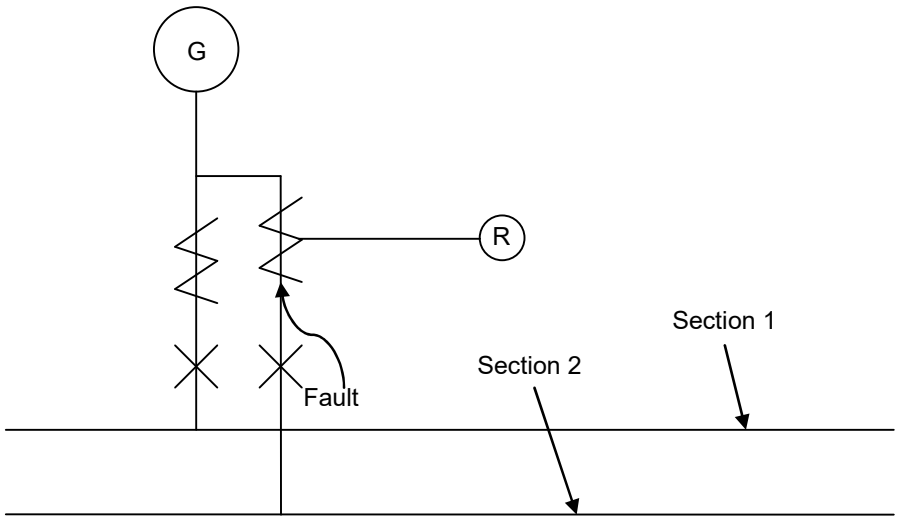
1.5.7 The DC control supply to Generator Controls & Relay Panel shall be redundant with supply failure alarm.

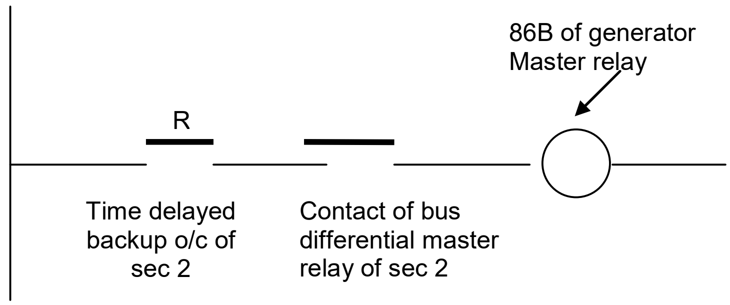
1.5.8 ***In case numerical type generator protection relay are installed, it is recommended to install two such relays in parallel mode, if feasible or otherwise one standby relay to be kept to meet emergency. Generator Numerical relay faulty alarm must appear in control room.***

1.5.9 The hardcopy of the relay logic and setting chart of generator numerical relays to be maintained at testing department and TPS operations for facilitating easy visualization of the total scheme and avoid mistakes while referring the soft copy with a part view.

1.5.10 The protection provided in generators for field failure plus under voltage should trip the generator instantaneously without any time delay. This should be ensured by checking the relay soft timer and the external timer. Similarly other protection logics should be ensured by checking the relay internal soft scheme during the annual protection testing.

1.5.11 During fault on incoming pole of the generator breaker, bus differential relay operation will not isolate the fault. In view of this following scheme is to be implemented to trip the generator and avoid wide spread affect.





Note: Current transformer (CT) – 'R' normally should be on the downstream side of the circuit breaker for achieving overlapping. However, it is observed that in most cases, it is provided in the upstream of the breaker and hence, the above mentioned scheme is desirable as overlapping is not available.

1.5.12 Proven schemes are to be used for generator differential/overall differential protection. If high impedance scheme is used, stabilizing resistances of correct ratings are to be used.

1.5.13 Static excitation system, which derives power from generator terminal is to be avoided. If the system voltage drops below 70%, then the static excitation system may not provide the required excitation to clear the fault and maintain the system voltage healthy.

1.5.14 For monitoring the health of the Gas Turbine Generator rotor, it is recommended to monitor the generator field current and excitation field current at particular loads. After establishing a base line data, monthly verification / testing to be done for any variations. The same to be indicated in the monthly MIS sheet of TPS.

1.5.15 The healthiness of CO_2 system of generator is to be checked through simulation during planned generator shutdown. Both the CO_2 cylinder batteries (main & standby) are to be maintained healthy. The cylinder should be weighed for their healthiness.

1.5.16 For new projects, DVR dual auto channel with dual PLC to be considered for enhanced reliability.

1.5.17 End terminations of generator cables during unit shutdown are to be critically checked for (a) crack (b) discolor (c) tracking (d) armor heating and a record of the same to be maintained.

1.5.18 The protection coordination of the generator voltage restrained/controlled over current protection (CDV) to be ensured with the over current protection of the outgoing feeders.

Wherever generator transformer is provided, Impedance based back up protection may be provided as backup to CDV protection.

In order to facilitate full implementation of above recommendations by identifying GAPs and preparing action plan, a check list has been developed for reference and is given at Section 1E of this chapter.

Chapter-1

GENERATORS AND GENERATOR AUXILIARY SYSTEM

1B - EXPLANATION TO RECOMMENDATIONS

Reference	Explanation
1.1.1	To prevent the reverse power operation of the generator, a scheme is provided, in STGs (old systems), to trip the Generator through Low Forward Power protection (LFP) with a time delay in the event of tripping of Steam Turbine. However in case of GTG's, where low forward protection is not applicable, it is desirable to have direct turbine trip command (from Mark-IV/V) without any delay to trip the generator. This shall prevent motoring of generator and maintain system stability. ***Although this feature exists in most of the locations as a standard scheme of BHEL, the same need to be ensured at all locations.***
1.1.2	In GTs, during the operation of Generator Unit Master Trip Relay (86U) / Generator Differential Relay, one NC contact is given to Mark –IV/V panel to trip the GT. There may be a possibility of undesired tripping of GT in case of loose connection or pulling out these relays for any emergency maintenance, when GT is in operation. It is normally not feasible to covert the tripping logic through NO contact in Mark-V. Therefore, it is suggested to use the NO contact of the 86U relay and invert the input status of the same in the Mark-IV / V software, in consultation with OEM. As a standard scheme, Mark-V uses only differential relay contact for turbine tripping, which should ideally be taken from 86U relay or both. Accordingly, the alarm tags in Mark-V should also be modified to avoid confusion. ***Modification in this regard has been incorporated in GT-3 at Mathura Refinery by BHEL during commissioning.***
1.1.3	There have been incidents of erroneous closing of idle generator breaker by operator through mechanical lever while racking out from service position. This resulted in asynchronous closing of generator breaker leading to severe system disturbances apart from safety of plant and personnel. To prevent such mishaps it is desirable that provision of mechanical closing the generator breaker from the breaker front plate is to be completely disabled.

1.1.4	In order to prevent inadvertent tripping of generator from Emergency Push button located at Generator Control Panel due to human error, it is desirable to provide two push buttons, in series.
1.1.5	To avoid human errors, suitable interlocks to be provided for ensuring that field breaker cannot be made " OFF" unless both the generator breakers are OPEN.
1.1.6	In order to prevent accidental closing of generator during synchronization process through "Auto Synchronizers", it is desirable to provide check synchronization relay contact in series with the "Auto Synchronizer" command. It is recommended to use SKE relays for generator synchronization as this model has permissible band suitable for generator application, whereas SKD is meant for Bus Transfer schemes.
1.1.7	In order to prevent spurious tripping of generator at Generator temperature high protection (100 deg C), it is desirable to take the tripping contact in series with the 80deg. C alarm contact or incorporate the logic 2-0-0-3 of the temperature sensors if practicable.
1.1.8	The Generator High Temperature trip command has been routed through a Fire Alarm Panel in a few locations. During control supply interruption/ change over in the Fire Alarm Panel spurious command gets generated to trip the Generator. It is, therefore, desirable to give DC supply / UPS AC supply to Fire Alarm panel.
1.1.9	Possibilities exist that generator space heater remains" ON "after the generator is taken into service. In order to avoid high temperature tripping of generator due to continued operation of space heater, it is recommended to control the space heater supply through generator breaker contacts or an alarm " Space Heater' ON" may be wired up to the control room.
1.1.10	There have been instances of tripping of generator due to PMG failure on account of shearing of bolts in the flexible coupling. It is desirable to check the healthiness of the coupling bolts & bushes in particular for the newly commissioned machines at every available opportunity.
1.1.11	The stroboscope facility provided in the exciter compartment for monitoring the healthiness of diode fuses becomes frequently faulty on account of lamp failure, vibration & heat in the exciter compartment. It is recommended to additionally procure portable hand held stroboscope gun for such requirement.

1.1.12	Since generator protection is not based on the fail-safe philosophy and "NO" contacts are used for various trip schemes. Any problem related to the cable or loose connections shall remain unnoticed till the protection actually operates. Moreover, there may also be a possibility that the trip commands from TNC switch and Generator master relay are combined in the generator relay panel / control panel and a common trip signal is wired to generator breaker for tripping. In such cases it will not be possible to trip the generator from either Master relay or TNC switch, if there is loose contact / break in the connection. Such situations may be disastrous in case of generator faults. In view of this, it is desirable to separately wire trip commands from the generator master relay and TNC switch to the breaker. (This is inline with the recommended standard scheme by BHEL)
1.1.13	Humidity sensors shall detect leakages in generator air cooler tubes through increase in humidity level of generator cooling air.
1.1.15	Continuous Temperature measurement in generator terminals and generator bus incomers can be done without affecting the integrity of the panel.
1.2.1	The bus-bar arrangement shall ensure operational flexibility and minimum disturbance to the running system in case of faults, system troubles and to facilitate emergency maintenance. It is desirable to have separate Generation Bus and Distribution buses in the Primary Sub Station of the power plant. (Refer Schematic Drawing No. 1C.1)
1.2.2	For system reliability, It is not desirable to have interconnection (Bus coupler) between the two generation buses of double bus configuration, as any fault in the common zone will trip the connected generators. The interconnection breaker, if provided, should be kept ' OFF'. (Refer Schematic Drawing No. 1C.2)
1.2.4	**In order to prevent heating of single core armoured cable due to circulating currents flowing through its Armour, which may lead to the failure of joints and end terminations, only one side earthing of the cable end terminations shall be done. Also proper TRIFOIL formation of the cables of the different phases is to be done by using clamps with transposing of the cable bunch at regular intervals. Transposition of Sheath and armour at cable joints will nullify the sheath & armour potential respectively.**
1.3.1	In case AVR control supply and input supply to bridge are taken from station supply, there are possibilities that AVR may not perform as desired during system voltage dips. This is because the reference and bridge input supplies shall also experience dip under such conditions

	causing the erratic AVR response. A number of generator trippings have been experienced due to inadequate AVR response during voltage dips. It is therefore recommended to provide AVR bridge input supply from PMG or UPS. Control supply of the AVR shall be preferably from a DC source.
1.3.2	In order to ensure proper operation of the AVR during the running condition, it is recommended to ensure that limiter settings are made as per generator capability curves (as provided by OEM) with all the limiters in service. These settings should be verified during the on line dynamic testing of the machine in line with the recommended procedure of the OEM.
1.3.3	Improper cable size selection between AVR & exciter may cause the set point of auto channel to attain maximum position (110%) at lower loads (MVAR) of the generator, thereby not allowing any further increase in AVR output to meet the increased MVAR demand. Therefore, the sizing of the outgoing cable from AVR to exciter shall be such that the cable voltage drop is Approx. 3 Volts or less at the rated load. It is also desirable that compensation of entire resistance (Exciter field winding & cable resistance) is done in the DAVR.
1.3.4	It has been experienced that during power system voltage dips DAVR switches from “Auto” to “Manual” channel. To prevent such un desirable operation, it is recommended to incorporate a time delay of 2.5- 3.0 sec.in the DAVR’s auto- manual changeover logic particularly for “Ug” actual value failure condition of DAVR’s. 100ms time delay in AUTO to AUTO changeover will ensure unwanted changeover from auto to auto channel in transient conditions.
1.3.5	DAVR’s are normally provided with both AC to DC and DC-to-DC power supply units to ensure its reliable operation. At some locations alarm has not been provided for AC supply failure. In such cases, when AC supply is not through, the machine will trip in the event of DC supply failure. Hence alarm for power supply failure is to be provided. The availability of both the supplies can additionally be ensured by alternately switching “Off” the input power to these supplies when generator is in unsynchronized & FSNL condition with full voltage.
1.3.6	In order to avoid field failure condition of the generator causing system voltage dip in case of AVR stage–3 faults (AVR Tripped condition), suitable interlock to trip the generator instantaneously shall be provided. This may be done by providing stage–3 faults contact from DAVR to Generator 86G master trip relay.
1.3.7	There have been instances that DVAR was not able to cater to system