Chapter 7. Real case study

Implemented in petroleum E&P organization

1. APPOINTED PERSONS (AP) PROCEDURE FOR LV MOTORS

Observation and Background:

Operation personnel working in remote areas (interior desert locations) faced difficult situations to isolate a rotating equipment (example oil Pump) , if they observe any spillage, leakage, oil deferment etc during their routine field monitoring activities. In fact they are deemed to communicate to the appropriate electrical personnel for isolating the faulty equipment and systems as per standard operating procedure. Eventually the mitigation or stopping of the leakage or unusual activity will take lots of time, resulting the loss due to time consumption

I have involved on this exercise with the help of team of other experts to resolve such situations hence the following procedure is developed

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INTRODUCTION:

Isolation Practice (Before Appointed Person procedure):

Electrical technicians were engaged for Isolation and De-Isolation of electrical equipment apart from their normal PM and corrective maintenance jobs. The Electrical departments were assigned for Isolation and De-Isolation of Equipments for the following tasks in general:

1. Discharge valve damaged
2. Choke valve malfunctioning
3. Driven pulley dislocated
4. Fin fan cooler belt broken
5. Suction strain cleaning
6. Tripping due to process fault
7. Belt changing
8. Oil changing
9. Seal replacement
10. Tripping due to vibration
11. Other urgent /normal mechanical and production activities.

Time Spent on ISOLATION that could be done by "APPOINTED PERSON":

The following figures give us an idea about the quantity of man-hours utilized by maintenance department for different tasks. This information has been collected from the data in available EPMARS System during the period from 2009-2011.

An average of approximately 1700 man hours in a year can be transferred from Electrical technicians to Production technicians (so called Appointed Persons).

Benefits of using APPOINTED PERSON:

The Production technician can be performed the same job of IMMOBILISATION, provided they should be properly trained and examined. The production Technicians can be given as "APPOINTED PERSON" for performing the stated procedures as in APPENDIX-C.

PROPOSAL GIVEN FOR APPROVAL:

To allow Production Technicians to immobilize LV motors which are fitted with lockable isolators and who are trained and assessed. The selected Technician should undergo different off the job technical modules mentioned in the Training procedure. Apart from off the job technical modules he should gain adequate technical practical experience while doing so under the supervision of Area Electrical Supervisor. The Area Operations Electrical Supervisor shall ensure that he is satisfied with the person's training and check that he is competent to carry out the specified activities detailed on the application form.

APPOINTED PERSON -Reference -ESOP

SELECTION,TRAINING,ASSESSMENT AND APPOINTMENT OF APPOINTED PERSON(APs)

GENERAL

- This procedure is issued to provide guidelines for the selection, training, assessment and appointment of individuals who are appointed under the ESR as APs.
- The method of applying to the corporate Function Discipline Head – Electrical (CFDH-E) for candidates to be appointed is detailed. Appendix A shows a specimen of the types of C of A in use.
- A periodic re-assessment of APs operational competence and discipline is called for on a regular basis.
- A proper registration system shall be kept of all matters pertaining to the training, assessment and appointment of persons.

USES AND SWITCHING DUTIES OF APPOINTED PERSONS

For use in certain situations, or at specific locations, there is the need of a person who can carry out tasks that would normally be done by Electrical Personnel as a small part of their operational duties. If a production unit or facility needs selected members of their staff to carry out duties that requires them to be of AP status ,then they shall approach the Area Operations Electrical Supervisor to check if they will agree to such appointments for any of the following activities:-

A. Carry out a specific limited HV SWITCHING from a position remote from the circuit breaker, or limited LV SWITCHING. This SWITCHING shall be limited to the closing and opening of circuit breaker or contactor controlling a generator, motor etc.

B. Enter substations under the control of an Area Operations Electrical Supervisor.

C. Carry out any other specific activity that is normally carried out by Area Operations Electrical Personnel.

D. It is essential that persons who are selected to carry out these types of tasks receive sufficient training, and clear instruction in writing, so they are warned of any potential hazards that may arise when they are carrying out them out.

TRAINING FOR APPOINTED PERSONS

GENERAL

- A copy of the Electrical Safety Rule (ESR) shall be made available to all candidates at least four weeks prior to assessment with a note setting out the sections that apply to this particular authorization. This is so the person can make himself familiar with the intention and details of the section of the ESR affecting the operation and the work he is to undertake.

- A copy of the Electrical Safety Operational Procedure (ESOPs) shall be made available at least four weeks prior to assessment to candidates to be authorized. This is so the person can make himself familiar with the specific ESOPs that affect the operations or work he is to undertake.

- All candidates shall attend a formal operational training to become familiar with the ESR and any ESOPs relevant to their intended "authorisation". This course shall be attended prior to authorisation.

TRAINING:

- The training of APs to carry out selected tasks shall be carried out under the supervision of the Area Operations Supervisor or his delegate.

- The person in charge of AP training shall have AEP status as minimum requirement.

- The importance of specifying the limits of clearly defined activities that such APs shall be allowed to carry out is the prime object of training.

ASSESSMENT OF CANDIDATES FOR APPOINTED PERSON

- An application from a production unit or facility for candidate to become an APPOINTED PERSON shall , following the necessary training , be sent to the Area Operations Electrical Department.

- The Area Operations Electrical Department shall ensure that he is satisfied with the person's training and check that he is competent to carryout the specified activities detailed on the application form.

- In particular , it is important that such candidates are aware of the limits of the operational duties they may be allow to undertake on the Electrical Systems.

- If the candidate is to be required to carry out limited SWITCHING duties , the Area Operations Electrical Supervisor shall produce a written procedure detailing the agreed items of SWITCHING and procedures he will carry out.This procedure shall be submitted to the appropriate Head of utility for approval before applying for the candidate's appointment.

APPOINTMENT OF APPOINTED PERSONS.

- carried out by the appropriate head of utility.
- All appointment shall be approved by the CFDH-E.
- Only after a successful assessment, shall the Head of Utility forward a completed Certificate of assessment (COA) to the CFDH-E for his final approval and signature. The CFDH-E shall return the COA to the Head of Utility, who shall ensure that the relevant person receives the COA.
- Specimen COA is shown in Appendix A.
- The COA shall be return to the appropriate Head of Utility when the person leaves or has his authorization withdrawn for any reason.

PERIODIC REVIEW OF APPOINTED PERSON

- The validity of the certification period is a maximum of three years. Well before the expiry date the appropriate Head of Utility, or a person nominated by him , shall carry out re-assessment of the person concerned.
- The re-assessment is to check the operational competence and discipline of such persons and ensure that they can perform their functions safely and efficiently.
- The Head of utility shall attend a site where the EP or AP is carrying out SWITCHING, or operational duties, and implement random checks , as detailed in the section below
- If a SWITCHING PROGRAMME is being used, it shall be checked for accuracy and legibility. Times of operation of individual items of SWITCHING shall have been recorded.
- If SWITCHING is in progress items that can be checked are :-
    - ✓ Correct log book or SWITCHING PROGRAMME entries?
    - ✓ SAFETY LOCKS correctly applied at points of ISOLATION?
    - ✓ Have CIRCUIT MAIN EARTHS (CME) been correctly applied, and if consisting of portable EARTHING leads, labeled ' CME '?
- If a SAFETY DOCUMENT has been issued , items that can be checked are :-
    - ✓ Is the document and its copy legible and ' printed '?
    - ✓ Does the recipient understand the work he is to undertake?
    - ✓ Is the information, E.g. - CME, accurate?
    - ✓ Have any ADDITIONAL EARTHS been issued, and recorded, on the ELECTRICAL SAFETY DOCUMENT?
    - ✓ Is the CONTROL PERSON's name recorded?
    - ✓ Are both issue and recipient sections properly signed?

- If the Head of Utility is satisfied with the result of re-assessment, then a new COA shall be issued for the next three years, duly approved by the CFDH-E. The old COA shall be destroyed.

RECORD OF TRAINING & ASSESSMENT AND REGISTRATION OF APPOINTMENTS: GENERAL

Each Head of Utility shall maintain an **up-to-date** recording and registration system for all EPs and APs assessed by him.

RECORDING OF TRAINING AND ASSESSMENT

The record system shall include in an auditable format.

- Full details of an individual's attendance operational training courses; run to make persons familiar with the ESR and ESOPs.
- Full details of an individual practical training, received in SWITCHING and operational procedures.
- Result of the assessment.

REGISTRATION OF APPOINTMENTS

The register of appointments shall include in an auditable format the following details of the persons appointed under the ESR-

- Name of the person(sur-&first name)
- Company number or employing Contractors name
- Region/Area
- Authorization level
- Date of appointment
- Date of LV/HV courses followed
- Focal point
- Acknowledgment of ESR received

- Issue and expiry date of certificate
- Re-assessment date
- Remarks

APPENDIX A

CERTIFICATE FOR APPOINTED PERSONS

To be used for AP

FRONT OF CERTIFICATE BACK OF CERTIFICATE

SPACEF OR PICTURE OF AUTHOR ISED STAFF	Name of company and logo CERTIFICATE OF AUTHORISATIO N **APPOINTED PERSON**	Name of company and Logo CERTIFICATE OF AUTHORISATION **APPOINTED PERSON** No:----------Level:----------Area:---------- Name:---------- Coy No/Coy:---------- Date of issue:----------Expiry:---------- Authorisation signature:---------- Head of Electrical Engineering
LEVEL:---------- ---------- AREA:---------- ----------		

NOTE: THE ABOVE PICTURE IS NOT TO THE SCALE OR DIMENSION

4)METHOD OF APPROACH

TRAINING PROCEDURE:

SLN	ACTIVITIES	PERIOD	ACTION BY	MONITORED BY
1	Selecting personnel for appointment of "APPOINTED PERSON"	1 week	**Area Electrical Supervisor** , Area Coordinator	Area Coordinator
2	Selected personnel should undergo the following technical courses- * ELECTRICAL SAFETY (LEL 040) * SWITCHING PROCEDURES AND PROGRAMMES (LEL 050) * ESR LOW VOLTAGE COURSE (LEL 060) * Isolation and de-Isolation" procedures.	10 days	Training Department	Area Coordinator
3	Selected personnel should familiarise the area under his perview and acquire good knowledge in the following areas- * Various types of switchgear and their operation in MCC room for which this procedure is applicable * RCU and their operations. * Identification of cables * Identification of equipment * Log book keeping etc.	2 months	Area Electrical Supervisor	Area Coordinator
4	On the job training to the selected personnel as per the standard procedures mentioned in APPENDIX C	6 months	**Area Electrical Supervisor**	Area Coordinator
5	Observe the selected personnel performing the procedures independently	2 months	**Area Electrical Supervisor**	Area Coordinator
6	Examination/Testing of selected personnel for giving "APPOINTED PERSON" authority	1 week	**Area electrical Supervisor**	Area Coordinator
7	Review of "PROCEDURES" to the "APPOINTED PERSONS"	every 6 months	**Area Electrical Supervisor**	Area Coordinator
8	Review the activities stated above	every 3 m	Area coordinator	Area Coordinator

METHOD OF ISOLATION:

APPENDIX C

PROCEDURE TO IMMOBILISE AN LV MOTOR FOR USE BY APPOINTED PERSONS ONLY.

PERMIT REQUIREMENTS

OPERATIONS WORK PERMIT

PROCEDURE

1. Ensure motor is stopped from process.

2. Motor Remote Control Unit:

- Check identification number is as given on work permit.
- Padlock in "OFF" position using SAFETY PADLOCK.

3. Motor Control panel.

- Identify correct cubicle as per work permit equipment tag number
- Move the Isolator to the **"OFF"** position.
- Fit **SAFETY PADLOCK** to lock isolator in position.
- Tie on **CAUTION NOTICE.**
- Fill up label and tag.
- Enter in the switch room/substation log book.

4. Motor Remote control unit:

- Unlock and switch to **"ON"** position to check motor will not start.
- Padlock in **"OFF"** position.
- Fill up label and tag.
- Put both the SAFETY PADLOCK keys in one of the KEY SAFE in the switch room and collect two keys.

5. Write**" IMMOBILISED"** and sign in section of the work permit.

6. Hand over one key safe key and work permit to the work party.

7. The green copy of the work permit and the other key should be given to the operator.

Notes:

- All locks used shall be **SAFETY PADLOCK** i.e. unique key type.
- The Tag/Label shall have date , time ,work permit number reason and by whom the motor was made dead. {use preprinted paper label with appropriate wording}
- Procedure must be followed in stated order of activities.
- There are different types of isolators /safety switches, ask if you are not certain how they operate.

All Manufacturers Maintenance Procedures shall be followed.

APPENDIX C

PROCEDURE TO RETURN LV MOTOR TO SERVICE FOR USE BY APPOINTED PERSONS ONLY.

PROCEDURE.

1. Permit holder completes sign of work permit and hand over the key.
2. Ensure work party has completed the job, tools and lifting equipment removed guards , covers etc. has been reinstated.
3. Motor control panel:
    - Open KEY SAFE and collect SAFETY PADLOCK keys.
    - Remove **CAUTION NOTICE, SAFETY PADLOCK** and Tag/label.
    - Move the isolator to the **"ON"** position.
    - Enter in the logbook.

4. Motor Remote Control unit.
    - Remove CAUTION NOTICE , Padlock and Tag/Label.

All Manufacturers Maintenance Procedures shall be followed.

GENERAL NOTES:

1. The APPOINTED PERSON can carry out only "specified limited HV switching from a position remote from the circuit breaker or limited LV switching" and shall not receive and complete ISOLATION-DEISOLATION CERTIFICATES.
2. The stated procedure shall be applicable only after making necessary amendments in the HSE manual or the Area Operations Authority deciding to waive the need for isolation.
3. This stated PROCEDURE is applicable only for LV motors.
4. In LV motor control room the Isolators installed varies from place to place. So proper familiarization is very much essential to the concerned personnel, depending upon the area in which the respective APPOINTED PERSON is working. On the Job Training is required.
5. The motor control panel room key is made available to the echnician (production).Head of Utilities to agree.
6. Since there will not be any physical gap between power side and load side on the control panel , we call this procedure is an immobilization rather than Isolation. This procedure will not prevent the motor starting inadvertently due to a fault or maloperation of the control circuit .(In case simultaneous failure of two safe guards)
7. In the interest of safety it is advisable that the immobilization is recommended that only for certain specific jobs like air compressor oil change, mechanical seal replacement general washing or cleaning etc. Total isolation must be done for PM's jobs and involving the unit shut down for days more than one day.
8. In case of shipping pumps, suction and discharge valves (whether MOV's or manually operated)are to be isolated before work starts. The types of MOV's vary from location to location. So separate procedure has to be followed to immobilize the MOV of the shipping pumps.

9. Isolation of LV or HV motor circuit requires opening of LIVE cubicle doors and withdrawing fuses or circuit breaker/contactor truck from cubicle. This ensures that the motor will not start under all circumstances. If it is intended to have isolation of LV motors done by non - electrical persons , those persons are to be authorised as CEP (COMPETENT ELECTRICAL PERSON) , It is possible to do so ,if the Head of Utility agrees.

10. Such persons shall undergo "OFF JOB "Training in basic electrical concepts , electrical safety, and familiarization of ESR (ELECTRICAL SAFETY RULES) and ESOP's(ELECTRICAL SAFETY OPERATIONAL PROCEDURES) besides "ON THE JOB TRAINING".

Results after Implementation in real case:

- ✓ Man hour added to Production /Field operations staff for mobilization and immobilization of Motors – 1700 Man hour
- ✓ Man hour released from electrical operation staff for electrical isolation and de-isolation of above activity 1700 Man hour
- ✓ Production / field operation staff is in different gathering station for field monitoring activity , so that they can act as an appointed person for mobilization and immobilization of these activities accordingly as and when required so that a huge amount of money and man hour could be saved in case of eventuality.

2. Electric Motor Failure Analysis – Cause and Effect diagram including real case explanation

D.1.3 Electric Motor Failure Analysis – A real Case study

Observation and Background:-

- A motor coupled with a beam pump (nodding donkey) in one of the oil production areas were constantly break down during in the winter season. I have involved as a Lead with the help of team of engineers to analyses the cause of failure. This particular well is a high producer well, producing more than 20,000 meter cube of oil per day. Hence the matter is more critical to resolve the problem.

- According to the facts, it is estimated that 92% of the electric motor failures occur at the start up. Most of these failures occur due to low resistance. Mechanical failures and over-current failures are also very common. New methods and techniques for motor failure analysis are improving

- Different kinds of nodding donkey pump and ESM motor pumps are installed in various oil wells to extract oil from the reservoir. Approximately 2000 motors coupled with pumps in various interior locations. It has been observed that ~ 40 number of motors are failed to start during winter seasons due to failure of embedded heaters in the yoke of these motors resulting the huge amount of loss oil production.

D.1.3.1Introduction

- Electric Motors are an integral part of Industries as many systems, applications, and services depend on them. The motors that are being supplied and used currently have long service life and a minimum level of maintenance is required to make sure that they perform efficiently. In industries, motors have to be maintained on a regular basis because they need to be in operation all the time- and because one small problem could cause a great loss to the organization.

- Usually in large organizations, a motor maintenance program is carried out in which the causes of motor failures are identified and some necessary steps are taken to avoid them or lower their impact. Motors need to be inspected regularly, and other maintenance activities need to be performed to ensure efficient operation. Whenever a problem occurs, it should be corrected immediately to avoid further loss.

D.1.3.2Common Causes of Electric Motor Failures

Following are the main causes of electric motor failures:

1. Over-Current
2. Low Resistance
3. Over heating
4. Dirt
5. Moisture
6. Vibration

These causes are briefly explained below:

- **Over-Current (Electrical Overload)** Sometimes it happens that the electrical devices start to draw more current than their overall capacity due to different operating conditions. When it happens, the motor is affected greatly because it happens very suddenly and cannot be predicted. To avoid this over current, there are some devices that need to be installed that can prevent it from happening. These devices are usually wired in the circuits. They automatically shut down the extra amount of current flowing in the circuit.
- **Low Resistance** Most of the motor failures occur due to low insulation resistance. This issue is considered to be the most difficult one to tackle. In the initial stages of motor installation, the insulation resistance is observed to be more than one thousand megaohms. After some time, the insulation performance starts to degrade at an alarming level because the resistance starts to decay gradually. After a lot of research, the solution has been found which can prevent low resistance failures. There are automatic devices that test insulation resistance from time to time and safeguard rotating equipment is installed that prevents such failures. It is important that the insulation performance is monitored at regular intervals.
- **Over Heating** Excessive heat in motors an cause a number of performance problems. Overheating causes the motor winding insulation to deteriorate at a very fast rate. For every ten centigrade rise in temperature, the insulation life is cut in half. It has been concluded that more than 55% of the insulating failures are caused by overheating. Overheating occurs due to a number of factors. Every electric motor has a design temperature. If a motor is started off at a bad current value, it starts operating in a much warmer condition than the design temperature. It is very important that the motors should be matched with their ideal current values. Overheating also occurs when an electric motor is forced to operate in a high

temperature environment. This causes the rate at which heat can be conducted to reduce at an alarming rate. The area where electric motors are operating must have a proper cooling system and a ventilation system should be there in case the cooling system stops working.

- **Dirt** Dirt is one of the major sources that cause damage to the electric motors. It can damage the motor by blocking the cooling fan which causes it's temperature to raise. It can also affect the insulating value of the winding insulation if it settles on the motor windings. Proper steps should be taken to prevent the motors from dirt. Shielding devices are available which are used for this purpose.
- **Moisture** Moisture also affects the performance of electric motors. It greatly contributes in the corrosion of the motor shafts, bearings and rotors. This can lead to an insulation failure also. The motor inventory should be kept dry all the time.
- **Vibration** Vibration are caused by a number of possible reasons such as the misalignment of the motor which causes the motor to vibrate. Corrosion affected parts also cause the motor to vibrate. The alignment of the motor should be checked very carefully.

Motors, however, do give warnings of impending failures that technicians can identify by using several predictive maintenance procedures, including insulation resistance testing, polarized index testing, and DC high-potential testing. By tracking the results of these tests over time, technicians can identify trends of deterioration.

The insulation resistance test is one of the predictive tests used to evaluate the condition of a motor's insulation. A megohmmeter applies a DC voltage, typically 500 to 2,500 volts, to a motor's windings and gives a readout of the resistance of the insulation. Since the test is highly sensitive to moisture and temperature, technicians should perform all testing when the motor is at ambient temperature and humidity levels are relatively low.

Polarized insulation testing also reports on the condition of motor's insulation, but it takes into account that insulation molecules polarize as they are tested, changing the test results. Where insulation resistance testing is rather short in duration, polarized insulation testing is performed over a 10-minute interval, with readings taken and 1 and 10 minutes.

The value taken during the reading at the 10-minute interval then is divided by the reading taken at the 1-minute interval to determine the polarization index. Insulation that is in good condition will yield indexes above one and will not change from one test year to the next. Falling values indicates that insulation is in the process of failing.

Finally, technicians can use DC high-potential testing to detect weaknesses in the insulation that generally are missed by both insulation resistance and polarized insulation testing. The test provides information on the dielectric strength of the insulation and can identify areas within a motor's insulation that are likely to fault to ground.

Test Method:

- The IR is measured with a high voltage DC supply and a sensitive ammeter. The DC supply must have a well regulated voltage; otherwise a steady state capacitive charging current will flow. The ammeter must measure currents smaller than a nano-amp.
- There are several special purpose 'megohmeters' available commercially. Sometimes these are known as Megger Testers, after the name of the instrument first developed for this purpose (Megger is a trade name of AVO). A megohmeter incorporates a regulated DC supply and an ammeter that is calibrated in megohms. Modern instruments can apply voltages exceeding 10 kV, and measure resistances higher than 100 GΩ.

The IR and PI test results will depend strongly on the humidity. If the winding temperature is below the dew point, there is no way that R1 and R10 or PI can be 'corrected' for the humidity. If the results are poor, then the test must be repeated with the winding above the dew point. It will probably be necessary to heat the winding in some fashion, sometimes for several days, to dry off the moisture that has condensed on the winding. IEEE suggests the IR and PI tests be performed with the winding heated above the dew point.

IEEE suggests that test voltages be higher than recommended in the past, because tests at higher voltages are more likely to find major defects such as cuts through the insulation in the end windings. Note that the test voltages are still well below the rated peak line-to-ground voltages of the windings. Thus the IR test is not a 'hipot' test. Table 1 shows the suggested test voltages.

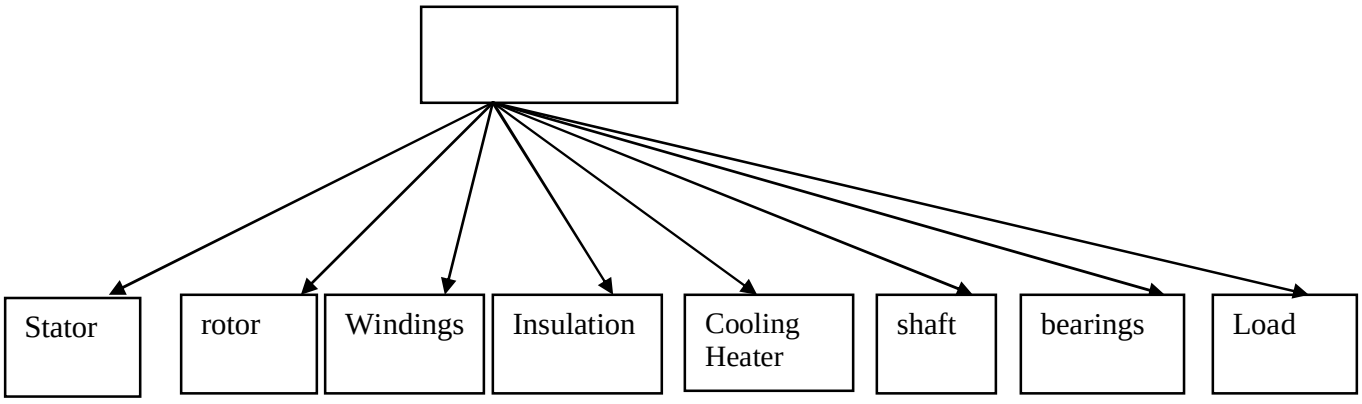
Table 1 Guidelines for dc voltages to be applied

Winding rated voltage(V)*	**Insulation resistance test direct voltage(v)**
<100 500	500
1000-2500	500 - 1000

2501-5000	1000 - 2500
5000-12000	2500 - 5000
>12 000	10 000

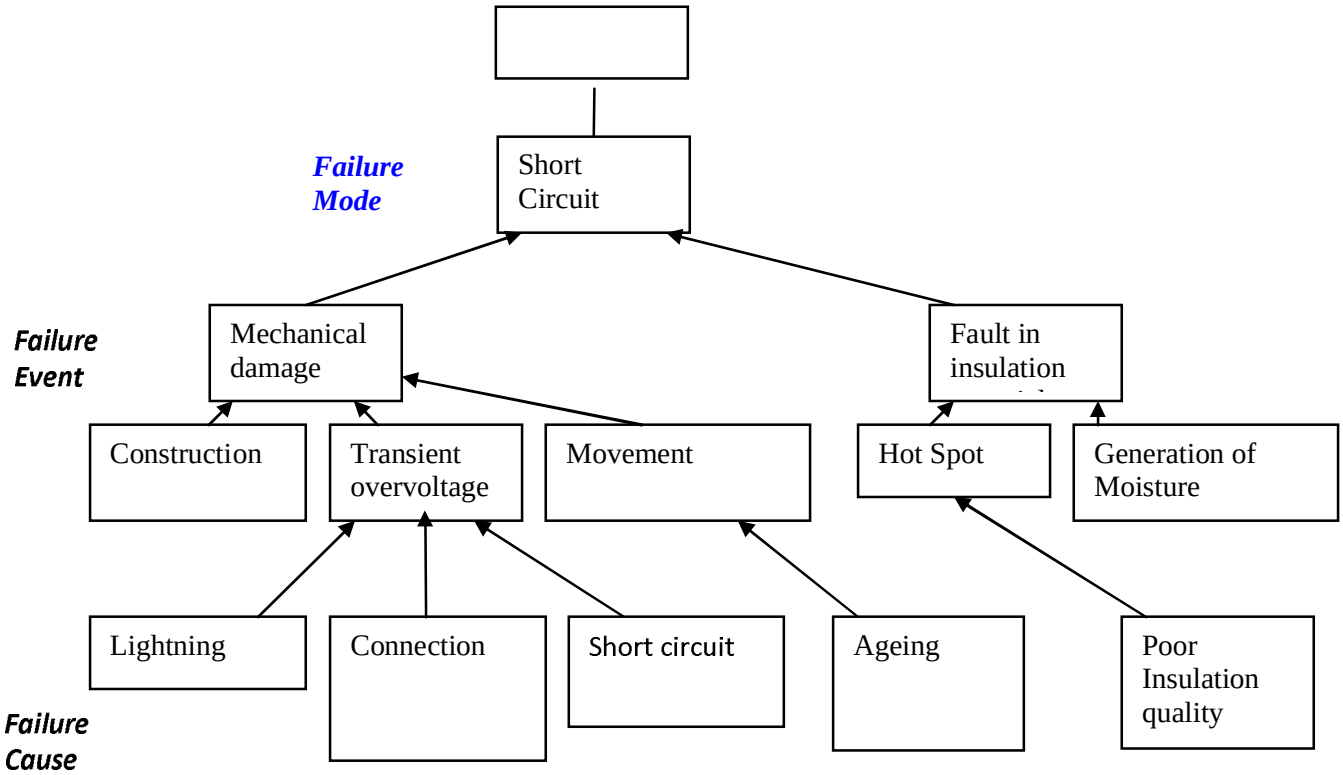
- Rated line-to-line voltage for three-phase ac machines, line-toground voltage for single-phase ac machines, line-to-ground, voltage for single-phase machines, and rated direct voltage for dc machines or field windings.

The major components of the Motor which are likely to cause failure of the Motor are



Windings:

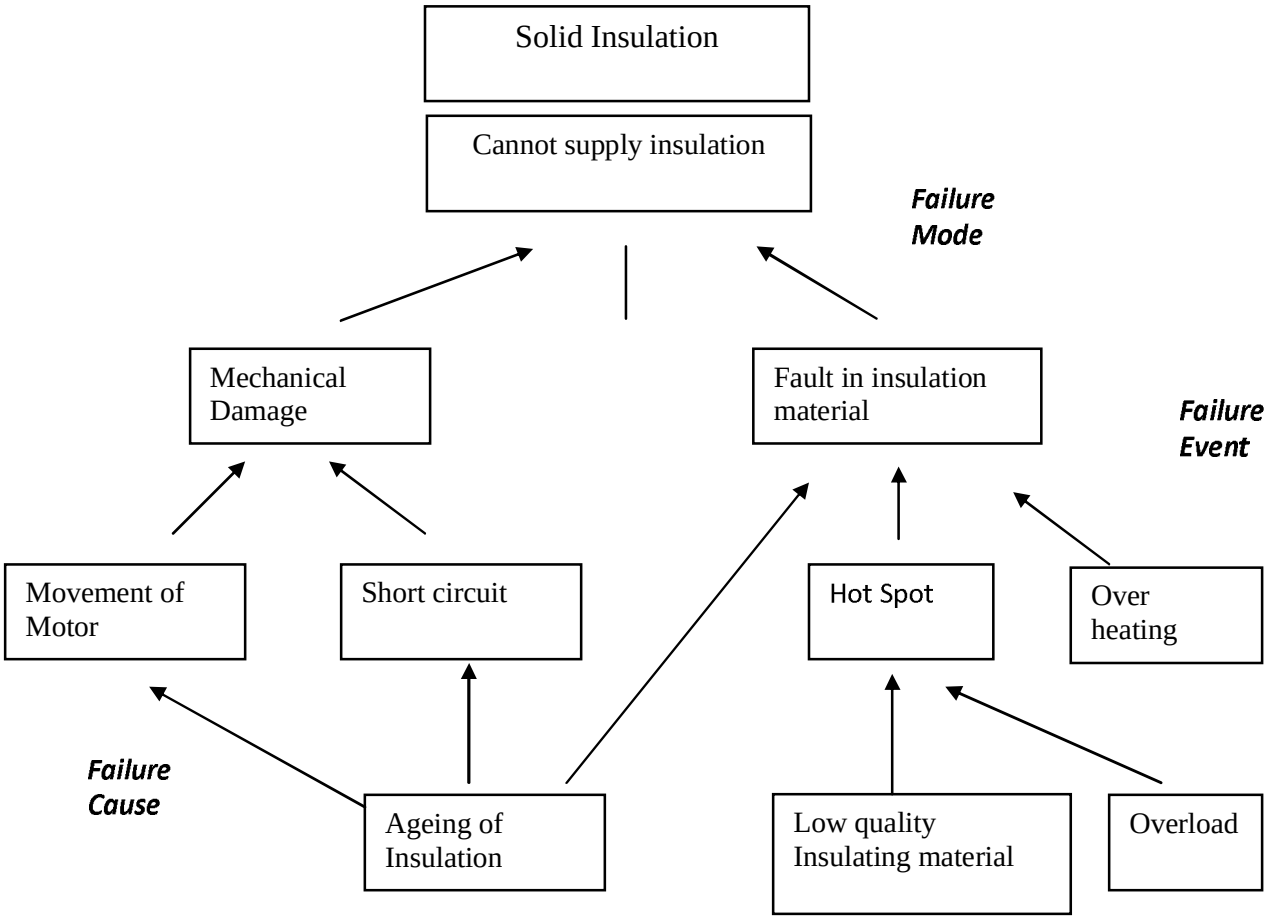
- Winding failures occur due to short circuits (turn-turn faults, phase-phase faults, phase-ground, open winding) ,transient overvoltage due to lightning or due to mechanical damage during the movement.
- A fault in the windings can also occur due to material faults in the cellulose isolation.



Fault Tree for Windings

Solid Insulation:

- The solid insulation in a motor is cotton and varnish based products such impregnated varnished insulation . Its function is to provide dielectric and mechanical isolation to the windings.



Fault Tree for Solid Insulation

Interpretation:

What constitutes a 'good reading' and a 'bad reading' depends on the nature of the insulation system and the component (stator or rotor) being tested. Until 2000, the minimum R1 and the acceptable range for PI was essentially the same for all types of stator winding insulation.

However, it has been recognized that the modern insulation materials in random wound and form wound stators have essentially no conduction current (as long as there are no cracks or pinholes). Thus it is possible for a clean, dry, form wound stator winding to have an R1 that is essentially infinite – greater than 100 GΩ.

With an R1 of infinity, calculations of a realistic PI are dubious. Such high R1's are not likely in systems made before the 1970's. Consequently, the maintenance person needs to establish the type of insulation used in the winding, or at least the approximate age of the winding, before interpreting IR and PI results.

Table 2 summarizes how to interpret IR and PI results in stator and rotor windings. The distinction between older and modern insulation systems was set at 1970, although this is somewhat arbitrary. Of note in this table:

- If R1 is below the indicated minimum, the implication is that the winding should not be subjected to a hipot test, or be returned to service, since failure may occur. Of course if historical experience indicates that a low R1 is always obtained on a particular winding, then the machine can probably be returned to service with little risk of failure.
- The minimum R1 is the value corrected to 40^{o}C. Unfortunately, any more than 10-20oC correction is unlikely to be valid.
- The minimum acceptable R1 is much lower for old stators than new stators, and it depends on voltage class.
- For modern stators, the minimum acceptable R1 only depends on whether it is a form wound or random wound stator.
- For modern form wound stators, if a very high R1 is measured (say greater than 5 GΩ), then PI is not likely to indicate anything about the winding. Thus, one can save time by aborting the test after the first minute of testing.
- If the IR or PI is below the minimum in a modern stator winding, it is only an indication that the winding is contaminated or soaked with water.

- If a high PI result is obtained on an older stator winding, then there is a possibility the insulation has suffered thermal deterioration. This occurs because thermal deterioration fundamentally changes the nature of the insulation, and thus the absorption currents that flow. The insulation has changed in an asphaltic mica winding if the asphalt has been heated enough to flow out of the groundwall.

Table 2-Recommended minimum insulation resistance values at 40^0C (all values in MΩ) Minimum Insulation Resistance

Minimum Insulation Resistance	TEST SPECIMEN
$R_{1\ min} = kV+1$	For most windings made before about 1970, all field windings, and others not described below
$R_{1\ min} = 100$	For most dc armature and ac windings built after about 1970 (form wound coils)
$R_{1\ min} = 5$	For most machines with random-wound stator coils and form-wound coils rated below 1kV

Notes

1 - IR 1 min is the recommended minimum insulation resistance, in megohms, at 40^0C entire machine winding

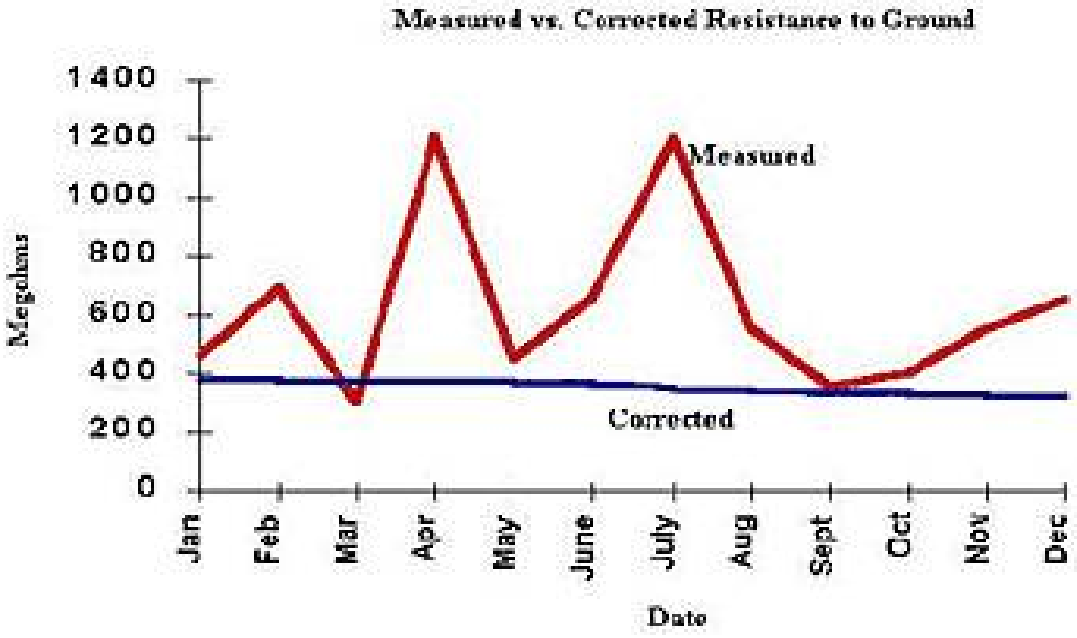
2 - kV is the rated machine terminal to terminal voltage, in rms Kv

In general, the IR and PI tests are an excellent means of finding windings that are contaminated or soaked with moisture. Of course the tests are also good at detecting major flaws where the insulation is cracked or has been cut through. In form wound stators using thermoplastic insulation systems, the

tests can also detect thermal deterioration. Unfortunately, there is no evidence that thermal deterioration or problems such as loose coils in the slot, can be found in modern windings

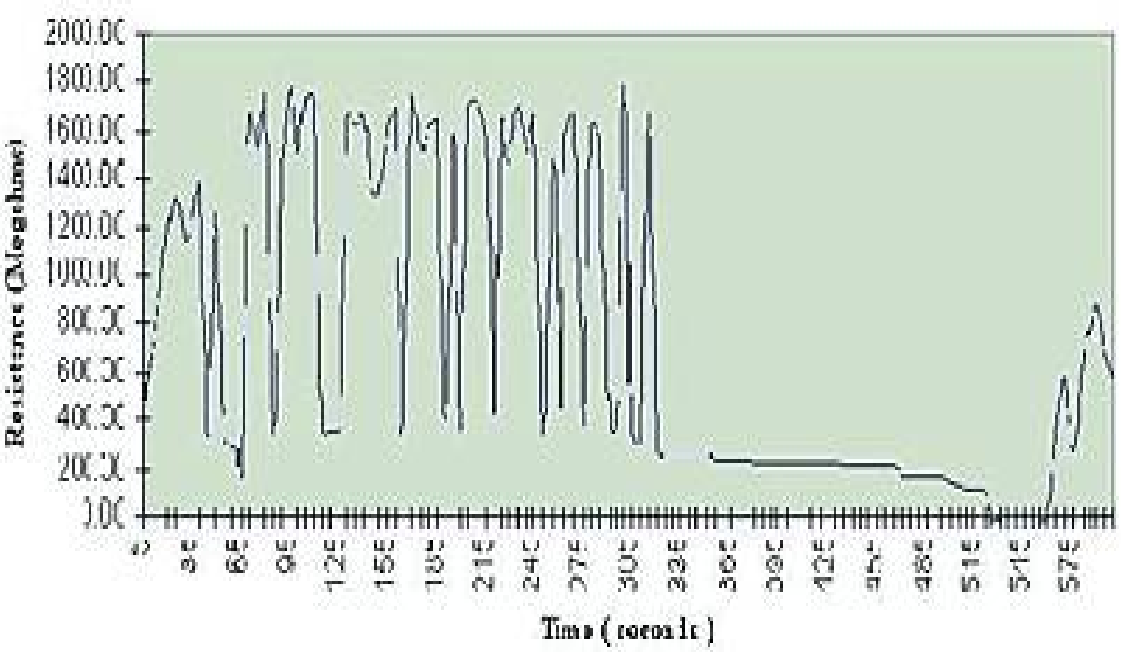
Insulation Condition:

- This refers to the insulation between the windings and ground. High temperatures, age, moisture and dirt contamination all lead to shortened insulation life. It has been said that if plants would just use the space heaters available to keep the insulation dry, then doubling the life of our motors would not be out of the question.
- Insulation systems today are better than ever and are able to handle higher and higher temperatures without significant reduction in life. However, still finding ways to destroy our insulation much earlier than should be expected. Keep in mind that although insulation is many times involved in a failure, this fault zone is heavily influenced by other problems. The power circuit for one can heavily influence the insulation. If a high resistance connection exists upstream of the motor, which develops better than a 5 percent voltage imbalance, and will continue to run the motor at its normal horsepower rating, and will see a shortened insulation life.
- Reverse sequence currents developing rotating magnetic fields in the opposite direction will not only reduce the torque capability, but can allow the temperature to rise out of control and exceed even the 150-degree Celsius limit on your Class F insulation systems.
- Was the insulation system the real cause of the motor failure or was it just a symptom? It is easy to diagnose the evident insulation failure as the fault mechanism but it will happen again with a different motor if the problem is not fixed. Then what will the explanation be?
- Again, testing with a Megger is not going to tell you everything, but it is a good start when it comes to insulation testing. Something that people often overlook when it comes to the IEEE (Institute of Electrical and Electronic Engineers) limits on resistance to ground is the reference to 40 degrees C.
- Simply Megger testing with no regard to temperature will result in resistance to ground readings, which swing heavily from high to low readings, depending on the temperature of the windings.
- Temperature correcting the readings will not only meet the IEEE testing requirements, it will give a much better trend as seen in Figure



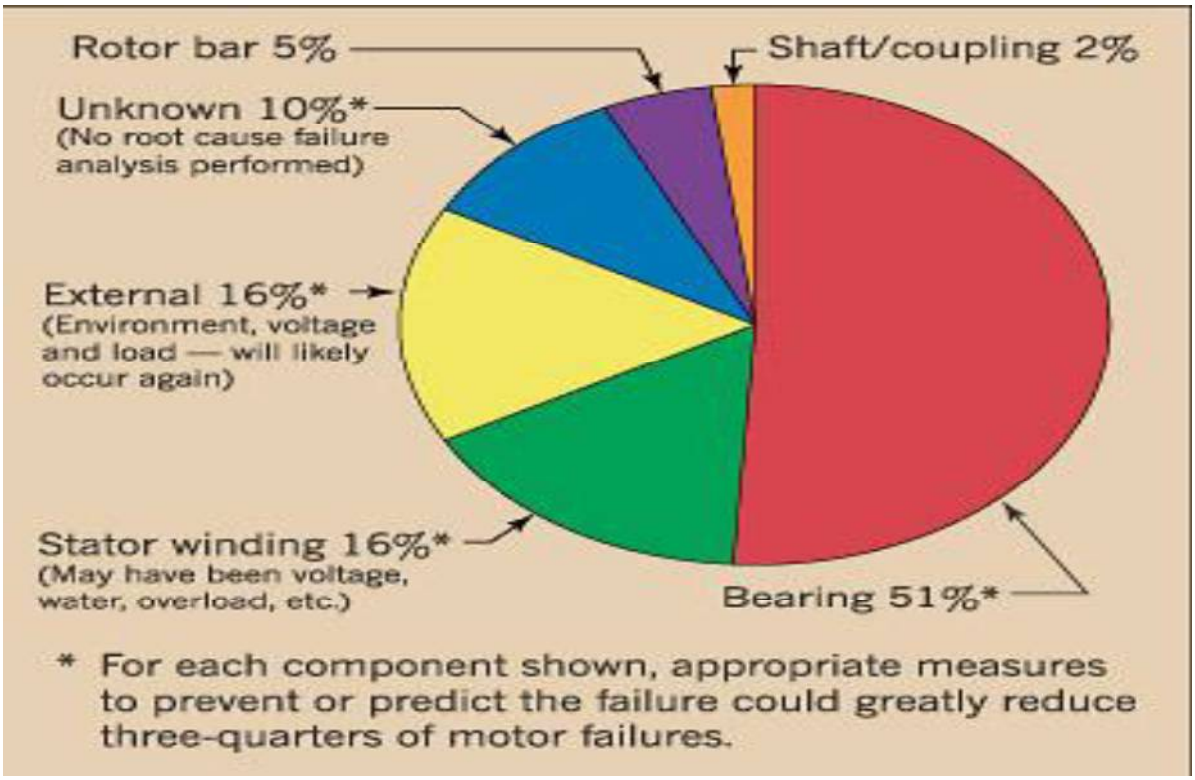
- The moisture contamination may cause the temperature corrected reading to be invalid. Ensure the heaters are energized when the motor is not running to prevent this from happening.
- An insulation test that has fallen out of the spotlight is the Polarization Index test. Applying a constant DC voltage, in the form of a Megger test, for a period of 10 minutes will result in a gradual increase in the resistance to ground (RTG) reading. This is a result of charging the insulation system, much like a capacitor, which causes a reduction in the absorption current. Per ohms law, I (current) = V (voltage) / R (resistance).
- Therefore, the reduction of this absorption current must result in an increase in the resistance. If we take the 10-minute RTG and divide it by the one-minute RTG, a value of 2.0 or higher is considered acceptable by IEEE. Unfortunately, motors with unstable insulation systems can give values close to or greater then a 2.0, but still be defective.

PI = 1.94



- In the above figure, when the 10-minute reading (approximately 600 megohms) is divided by the one-minute reading (approximately 300 megohms), the result is 1.94. This nearly meets the IEEE specification as a good insulation system, and would probably be accepted in the field. You can see, however, that this insulation system is very unstable. **Always look at the PI Profile and not just the index.**
- A limiting factor about DC resistance to ground testing is that the DC signal will many times not give the best evaluation of the true insulation condition. The insulation on a motor is a natural dielectric material. Therefore, it is a poor conductor of DC.
- This is good because you don't want excessive leakage to ground, but bad in that an insulation system in a degraded condition may take a bit longer to be identified using a DC signal or Megger. AC, however, does not allow the dielectric to charge and will pass through the dielectric much easier.
- This is good because it allows the use of an AC signal to give much earlier indications of insulation degradation and bad because it can be destructive, as with an AC Hi-Pot. Low-voltage capacitance to ground tests,however, are non-destructive and very good early indicators of degradation modes in your insulation systems. These values will be read in pico farads (pF) and can be effectively trended over time.

As the industry's approach to maintenance and repair gradually evolves from reactive and preventive to diagnostic and predictive, it's important to pay more attention to root cause failure analysis. Neglecting to do so often will cause your motors to repeatedly fail and cost you valuable resources and time.



Failure surveys. It's common to use the results of failure surveys to diagnose the cause of a specific motor failure, but it can be a costly mistake. Most failure survey data for electric motors is influenced by the particular industry, the geographic location, and the combination of the motors in use. Therefore, specific numbers may not always be relevant.

Findings:-

This particular beam motor installed in one of the remote locations was facing break down problems during winter seasons. Team Checked all the above parameters as per the standard operating procedure with the help of standard tools and equipment's.

Investigation:

It has been observed that the space cooling heater embedded in the stator or yoke of this particular motor was faulty and it was not working at all to maintain the temperature of the equipment as required. During winter season, it has been observed that the condensation was more and thereby

weakening the IR value of stator windings and the motor was tripping very frequently hence resulting the loss of production on often intervals.

It has been decided to conduct a detail overhauling and inspection checks of this particular machine in major workshop at the sites.

Observation

Huge amount of production loss (700,000 cub meters) is observed due to the failure of starting the motors duet to failure of embedded heaters in the motor. A large amount of maintenance team is involved to rectify the fault.

A special task force is formed to mitigate these failure on urgent basis. Preventive maintenance team is strengthened and intensive training is stream lined to educate the failure and subsequent consequences.

Results- Production loss is reduced a lot since the failure rate is considerably low due to effective implementation of Preventive maintenance techniques and training of maintenance task force.

Immediate action in terms of Number of Pumps overhauled

Number of various pumps checked and replaced with proper space heaters during overhauling – 79 numbers from various exploration and production locations

Results after Implementation:

Beam pump start functioning without any frequent failure or breakdown

4. Waste Management system – Battery disposal

Real case study and Implementation methods

In one of the oil and gas waste management system (wms) yard, batteries are disposed without standard procedures resulted catching fire and major portion of the yard got damaged under fire. Batteries must be discharged completely prior to dispose in waste management yard.

Observation:-

A portion of Huge WMS Yard (Waste Management system) in one of the remote locations of Exploration and Production (E&P) yard is burned due to failure of proper method of disposal of hazardous waste (battery). Approximately 800 lead acid batteries are to be discarded and disposed to waste management yard in annual basis from various remote locations.

Introduction:

- Lead Acid Batteries are portable electrochemical devices that store electrical power and are commonly used to operate a variety of electronic and mechanical appliances. Batteries are required to be charged and have a useful life after which they are to be disposed of. The battery cells contain lead, a well-established toxic compound. Sulphuric acid electrolyte is a strong corrosive solution and may carry soluble lead and lead particulates.
- Uncontrolled disposal of Used Lead Acid Batteries (ULAB) has a potential to contaminate surface and groundwater and soil resulting into serious health hazards and hence ULAB is classified as a hazardous waste, under the Basel Convention. Risk of environmental damage and safety hazard may arise from possible leak of the electrolyte from the spent batteries during their transport for disposal and hence a special care is required.
- Various laws have been enacted universally for the disposal of ULAB in a safe and environmental friendly manner. In India, under The Environment (Protection) Act, 1986, The Batteries (Management and Handling) Rules, 2001 and amendments thereof, The Hazardous Wastes (Management, Handling and Trans-boundary Movement) Rules, 2008 have been notified to make ULAB management in line with the Basel Convention and international practices.

Responsibilities:

- Site/location/business unit and line management have the responsibility to implement this standard.
- Each site/location/business unit shall institute a system for management & handling of ULAB consisting of collection, storage, transport and disposal in a safe and environment friendly manner by depositing in lieu of trade or sale to the authorized dealer, manufacturer or registered recycler and by no other means.
- Each site/location/business unit shall establish and maintain a list of Approved Commercial Lead Acid Batteries authorized dealers, manufacturers and registered recyclers. Further, each site/location/business unit shall establish and maintain a process for approval of the lead acid batteries authorized dealers, manufacturer and registered recyclers and their audits by constituting a sub-committee drawing members from concerned departments, plants and the site/location/business unit Environment Cell.

Definitions:

- **Approved registered recycler** means the ULAB recyclers that have been duly authorized / registered / recognized by the statutory authorities, which is audited by the site and found to be acceptable.
- **Approved manufacturer and their authorized dealer** means the lead acid batteries manufacturers and their authorized dealers that have been duly audited by the site and found to be acceptable for the deposition of ULAB in lieu of trade.
- **Auction** means bulk sale of used lead-acid batteries or component (s) thereof by invitation of tenders, or auction, contract of negotiation by individual(s), companies or Government departments.
- **Auctioneer** means a person (s) who auctions used lead-acid batteries or components thereof.
- **Authorized Dealer** means a person authorized by the manufacturer who sells and receives lead acid batteries or components thereof to and from the consumers on their behalf.

- **Battery** means lead acid battery, which is a source of electrical energy and contains lead metal.

- **Bulk Consumer** means a consumer such as Central or State Government Departments of Railways, Defense, Telecom, Posts & Telegraph, State Road Transport Undertakings, State Electricity Boards and others who purchase batteries through central 'rate' or running contract centrally placed on behalf of individual departments or user units under their jurisdiction.

- **Components** mean lead bearing components of a lead acid battery.

- **Consumer** means a person using lead acid batteries, excluding bulk consumers.

- **Registered Recycler** means a recycler registered with the Ministry of Environment and Forests or an agency designated by it for reprocessing used lead acid batteries or components thereof.

- **Used Batteries** means used, damaged and old lead acid batteries or components thereof.

Standards and Guidelines:

- Site/location/business unit shall establish and maintain a process for safe collection, storage, transport and disposal in a safe and environmentally friendly manner by depositing in lieu of trade or sale to the approved authorized dealer, manufacturer or registered recycler and by no other means, in compliance with the statutory requirements and guidelines issued by HSE.

- Site/location/business unit should purchase the maintenance free lead acid batteries as a green purchase policy.

- Site/location/business unit shall ensure that ULAB are duly discharged and are disposed off preferably by depositing in lieu of trade with the manufacturer or their authorized dealer.

- Only in case where the disposal of ULAB or their components is not possible through the approved manufacturer or its authorized dealer, their disposal shall be through approved registered ULAB recycler.

- Site/location/business unit shall establish and implement process for mitigating environmental impacts and safety hazards during handling of ULAB with specific reference

to lead and corrosive electrolyte.

- Sites/locations/business units shall maintain a list of lead acid batteries manufacturers, their authorized dealers and registered ULAB recyclers and shall establish and implement a process for its approval.

- Sites/locations/business units shall impart training to employees and contract workers on the environmental impacts and safety hazards associated with the handling of ULAB and its electrolyte.

Management Systems:

Support Resources

- Site/ location/ business unit Environment Cell, Safety Department and Centre for HSE Excellence are available for assistance with the implementation of this standard.

Management Records

- Site/ location/ business unit Environment Cell shall establish and maintain deposition/sale records, statutory submissions and retain letters that document approved exceptions.
- All records shall be retained in compliance with the Corporate HSE Records and Information Management Program.

Audit Requirements

- ULAB management and handling system of sites/ locations/ business units shall be periodically audited as per Company HSE audit process requirements. Site/ location/ business unit environmental audit sub-committee shall audit the approval process.

Standard Renewal Process

- This standard shall be reviewed and revised as necessary and at a minimum, not later than five years from the date of the last revision.

Deviation Process

- Deviations from this standard must be authorized by the site/ location/ business unit chief in consultation with Centre for HSE .
- Deviations must be documented, and documentation must include the relevant facts supporting the deviation decision.
- Deviation authorization must be renewed periodically and no less frequently than every three years.

Training and Communication Requirements

Each site/ location/ business unit affected by this standard shall be responsible for training of persons involved in management & handling of ULAB and implementation of this standard and respective guidelines and processes. In the event that interpretation or clarification of the standard is needed, questions shall be directed to the respective site/ location/ business unit Environment Cell and Centre for HSE Excellence for resolution.

Lead Acid Battery Scrap Recycling:

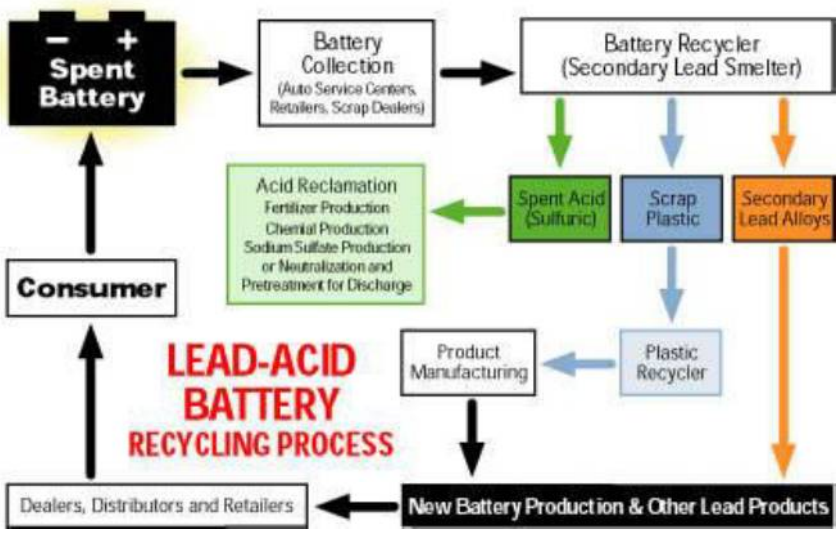
- Recycling by definition is the reuse of materials, either pre-consumer or post-consumer, that would ordinarily be considered waste. Recycling helps lessen the amount of waste that goes into landfills, helps reduce the amount of toxic chemicals absorbed into the earth and, in some cases, significantly reduces manufacturing costs and energy consumption.
- **Battery Recycling** is good for the Earth and good for future generations. **Battery Recycling** is the act of processing used or abandoned Batteries, which would otherwise be considered waste and harmful to our environment.
- Many communities have curbside **Battery Recycling** services to help out and there are **Battery Recycling** centers all across the country where Spent Battery can be brought.

Often times **Battery Recycling** centers pay you for dropping Spent Battery off, so it's a win-win situation.

There are many misconceptions about what materials can and cannot be recycled. These misconceptions hinder the success and cost-efficiency of recycling programs worldwide. However, with a little consumer education, recycling can be a very important and environmentally sound solution to waste management.

Lead Acid Battery Scrap Processing:

- Modern batteries are often promoted on their environmental qualities. Lithium-based batteries fall into this category. While nickel-cadmium presents an environmental problem on careless disposal, this chemistry continues to hold an important position among rechargeable batteries.
- Power tools are almost exclusively powered by nickel-cadmium. Lead-acid batteries continue to service designated market niches and these batteries also need to be disposed of in a proper manner.
- Lithium-ion would simply be too fragile to replace many of these older, but environmentally unfriendly, battery chemistries. The Lead-acid battery has led the way in recycling.
- The automotive industry should be given credit in organizing ways to dispose of spent car batteries.
- In the USA, 98% of all Lead acid batteries are recycled. In comparison, only one in six households in North America recycles batteries.



FLOWCHART: Lead ACID BATTERY RECYCLING PROCESS

- Although nickel-metal-hydride is considered environmentally friendly, this chemistry is also being recycled. The main derivative is nickel, which is considered semi-toxic. Nickel-metal-hydride also contains electrolyte that, in large amounts, is hazardous.
- Most lithium batteries are non-rechargeable and are used in cameras, hearing aids and defense applications. For proper disposal, the batteries must first be fully discharged to consume the metallic lithium content.

- **Battery Recycling Plant** require that the batteries be sorted according to chemistries. Some sorting must be done prior to the battery arriving at the recycling Plant. Nickel-cadmium, nickel-metal-hydride, lithium-ion and Lead acid are placed in designated boxes at the collection point.

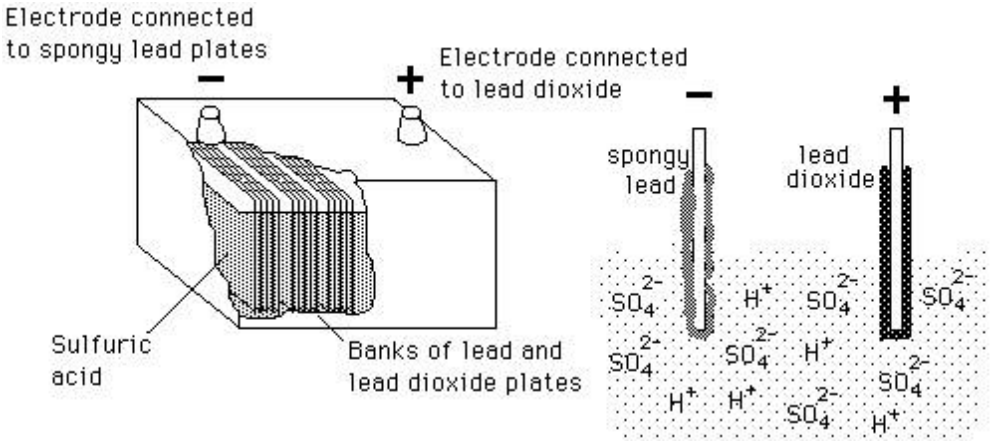
- Battery recyclers claim that if a steady stream of batteries, sorted by chemistry, were available at no charge, recycling would be profitable. But preparation and transportation add to the cost.
- The recycling process starts by removing the combustible material, such as plastics and insulation, with a gas fired thermal oxidizer. Gases from the thermal oxidizer are sent to the plant's scrubber where they are neutralized to remove pollutants.
- The process leaves the clean, naked cells, which contain valuable metal content.
- The cells are then chopped into small pieces, which are heated until the metal liquefies. Non-metallic substances are burned off; leaving a black slag on top that is removed with a slag arm.
- The different alloys settle according to their weights and are skimmed off like cream from raw milk.
- Cadmium is relatively light and vaporizes at high temperatures. In a process that appears like a pan boiling over, a fan blows the cadmium vapor into a large tube, which is cooled with water mist.
- This causes the vapors to condense and produces cadmium that is 99.95 percent pure.
- Current **Battery Recycling** methods requires a high amount of energy. It takes six to ten times the amount of energy to reclaim metals from recycled batteries than it would through other means.
- Batteries contain a range of metals which can be reused as a secondary raw material. There are well-established methods for the recycling of most batteries containing Lead, nickel-cadmium, nickel hydride and mercury. For some, such as newer nickel-hydride and lithium systems, recycling is still in the early stages.
- There are a number of different **Battery Recycling** processes, which are aimed at recovering a variety of materials:
- Lead can be recovered by either separating the different materials that make up the battery (Lead, plastics, acid, etc.) prior to metallurgical processing. Alternatively, batteries can be processed as a whole through heat treatment in a particular type of furnace with metals being recovered at the end of his process.

- NiCd batteries can be reprocessed through a similar thermal technique, which recovers cadmium and iron-nickel for steel production.
- Batteries containing mercury (button cells) are most commonly processed using a vacuum-thermal treatment, in which the mercury vaporises.
- It condenses and eventually solidifies when temperatures are reduced and can then be reintroduced into the material cycle. NiMH batteries are reprocessed by mechanically separating the individual materials (plastic, hydrogen and nickel) within a vacuum chamber to prevent the escape of hydrogen.
- The output of this process is a product with high nickel content which can be used in the manufacture of stainless steel.
- Li-Ion batteries are currently reprocessed through pyrolysis (heat treatment) with the primary recovery the metal content.
- Zinc-carbon/air and alkaline-manganese batteries can be reprocessed using a number of different methods, which include smelting and other thermal-metallurgical processes to recover the metal content (particularly zinc).

Battery discharge kit:

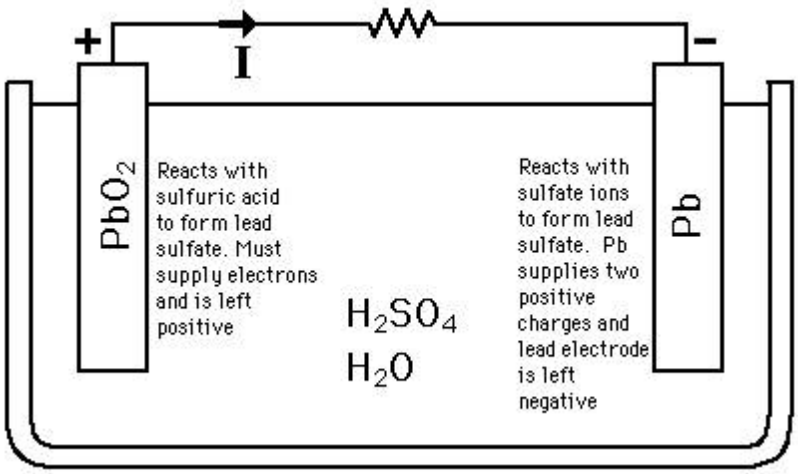
Lead-Acid Battery

Batteries use a chemical reaction to do work on charge and produce a voltage between their output terminals.



Discharge

The reaction of lead and lead oxide with the sulfuric acid electrolyte produces a voltage. The supplying of energy to and external resistance discharges the battery.



Consequences if the battery is thrown to yard without discharging:

Always there is a possibility of shorting the positive and negative leads of battery resulting the short circuit and generating the fire in the waste management yard. Be careful the battery is completely dead prior to dispose the same in to yard.

Disposal to Waste Management Yard:

- We discharge the battery completely by connecting suitable resistance across the battery terminal and allow the battery to discharge completely.
- We will ensure the battery is completely discharged by checking the voltage with the help of voltmeter & make sure that the electrolyte is completely drained out from lead acid battery
- **Observation:-** A portion of Huge WMS Yard (Waste Management system) in one of the remote locations of Exploration and Production (E&P) yard is burned due to failure of proper method of disposal of hazardous waste (battery) . Approximately 800 lead acid batteries are to be discarded and disposed to waste management yard in annual basis from various remote locations.

- **Implementation technique:-**

  A pedestal battery discharge kit is installed near to the battery disposal area and the concerned technician is trained and given responsible to ensure the battery is completely discharged before disposal to the Yard. Proper training will be given to the concerned on periodic basis so that the personnel will follow the battery discharge and disposal procedure as per standard maintenance craft procedure.

- **Result:-** No fire hazard after the effective implementation of discharge kit and proper training given to the concerned operation personnel

Conclusion

Based on the study carried out and interaction with the concerned personnel in the Industries the major conclusions are summarized as under:

Across the world safety in construction is a matter of concern. In India this is one of the most vulnerable segments of the unorganized labor in the country. The industry being highly labor intensive safety should be comprehensively addressed at an all India level. A large number of workers are exposed to the risks of workplace accidents and occupational health problems. Therate of fatal accidents in this sector is four to five times that of the manufacturing sector.

This report has attempted to explain the different facets of establishing HSE culture in Industry, with a view of understanding the process involved.

One of the major conclusions that can be drawn from this study is that construction, operations and engineering processes have inherent health and safety risks associated with them because of the very nature of the work. However, it is the responsibility of the authorities, of construction and operation companies and of the public in general, to strive to reduce accidents as much as possible because of the human tragedy that takes place in the wake of every single accident.

Thereby a safety culture needs to be developed as an integral part of the work culture of an organization. It must be a basic component of the management philosophy just as one of the key performance Indicators in the Industry. The aim should be at providing a safe work layout and work arrangements which are conducive to promote the health and well being of the workers which ultimately generates the feeling of trust and loyalty among the workforce.

Evaluation of Individual and Group Culture specifically with respect to HSE in turn influences the safe behavior of the employees and subsequently improves the productivity of the organization, reducing the Lost time Injuiry and reducing the down time of equipments and systems. This has been already implemented in the Industries.

Due to Dual skilling- safety culture on operational or production personnel working time is optimized. As described in the implementation plan, there is no need to depute an Electrical personnel for immobilizing an electrical equipment if an operation personnel is observed a oil leakage or gas leakage while doing his/her routine field monitoring checks. They can immobilize that particular equipment and systems to avoid suck leakages immediately to avoid further dangerous scenarios. This has been Implemented in the Industry where I worked. The real appointed person procedure has been shown in the implementation Plan as well.

Implementation of robust safety culture and safe working practices will lead to an efficient , effective and safe working ambience in the Industry. I am assuring to implement these best practices can be implemented in various Industries in the forthcoming period.

Abbreviations

ALARP	As Low As Reasonably Practicable
BBS	Behaviour Based Safety
BOE	Barrels Of Oil Equivalent
CA&A	Competence Assurance and Assessment
CEPI	Composite Environmental Performance Indicator
CFC	Chloro Fluoro Carbon
CHCS	Contractor Holdership Certification Scheme
EIA	Environmental Impact Assessment
EPI	Environmental Performance Indicator
ESSW	Enhanced Site Supervision Workshop
FAR	Fatal Accident Rate
FERM	Fire and Explosion Risk Management
GWP	Global Warming Potential
H&MT	Hearts and Minds Tools
HEMP	Hazard and Effects Management Process
HRA	Health Risk Assessment
HSE MS	HSE Management System
IVMS	in Vehicle Monitoring System
JHA	Job Hazard Analysis
JMR	Journey Management Rate [km driven / man-hours worked]
KPI	Key Performance Indicator
LCC	Local Community Contractor
LTI	Lost Time Injury
LTIF	Lost Time Injury Frequency [LTI's / million man-hours worked]
LTOIF	Lost Time Occupational Illness Frequency
NORM	Normally Occurring Radioactive Material
PFAT	Product Flow Asset Team
PTW	Permit To Work
QRA	Quantitative Risk Assessment
RAS	Roadworthiness Assurance
RSMT	Road Safety Monitoring Teams
RTA	Road Traffic Accident
SAQ	HSE MS Self Assessment Questionnaire
SIEP	Shell E&P International
STOP	Safety Training Observation Program
TRCF	Total Reportable Case Frequency (Total Reportable Incidents/million manhours)
TROIF	Total Reportable Occupational Illness Frequency
VIAR	Vehicle Injury Accident Rate [RTA LTI's / 100 million km driven]
YTD	Year to Date

Appendix

APPENDIX 1

PART 1 SAFETY QUESTIONNAIRE

ACTIVITY 1:

Following is a table which describes different cultural descriptions:

TYPE OF CULTURE	DESCRIPTION/MEANING
COLLABORATIVE?	Where collaboration and teamwork are fostered.
BLAMING?	Where the appropriating of blame is seen as important.
COMPLIANT?	Where everyone strives to follow rules and procedures.
CONSIDERATIVE?	Where employee's views and thoughts are sought and valued.
CO-OPERATIVE?	Where everyone is involved and work together.
CONSTRUCTIVE?	Where interaction to solve problems is encouraged.
LEARNING?	Where employees learn from mistakes.
RESPONSIBLE?	Where unacceptable behaviour is recognised.

Pick out a word from the column in the left from the above table which best describes your view of the Culture prevailing in ORCHID CROWN Project site:

ACTIVITY 2:

Make a list of key individuals whom you think might influence **HSE culture**

S.NO.	NAME	DESIGNATION

ACTIVITY 3:

Given below is an incomplete sentence and in order to complete it, select one option from the table given below which best describes your opinion by ticking against the appropriate box.

I see **safety** as "_____"

Options for filling the blank	Tick on the appropriate box
Something in which I know what is right but I do not do it properly all the time.	
Something in which I know what is right and I continuously strive to be better and I always care for my colleagues	
Something in which I do not care unless/until I don't get caught and I always focus on myself only.	
Something in which I get it right all the time and I share my attitudes with my colleagues and I know we all are genuinely committed.	
Something in which I look out for myself and concern for others only after accidents occur.	

APPENDIX 2

PART 2 SAFETY SURVEY

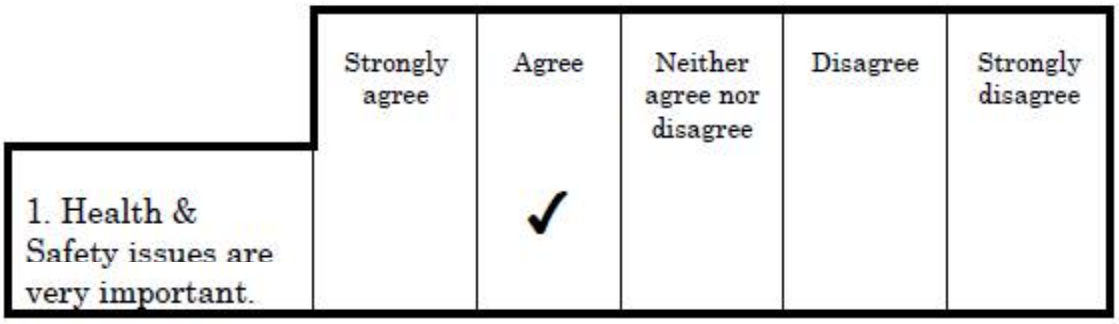
I would like to find out how you feel about your company safety practices and principles, and in order to do this I would like you to complete this questionnaire.

It is important for you to be completely honest about your feelings. All responses will be treated in strict confidence and there is no requirement to put your name to the questionnaire. The responses will be processed in confidence.

It should take 15 to 20 minutes to complete this questionnaire. I would like you enter your company, department/team and job function to assist us with the interpretation of the results.

Thank you for your co-operation.

You will be presented with a series of statements on the following pages about health and safety. You should indicate your response by ticking the appropriate box. For example, if you agreed with the following statement you would tick under the 'I agree' category, thus:



Company_____

Department/Team_____

Job Function_____

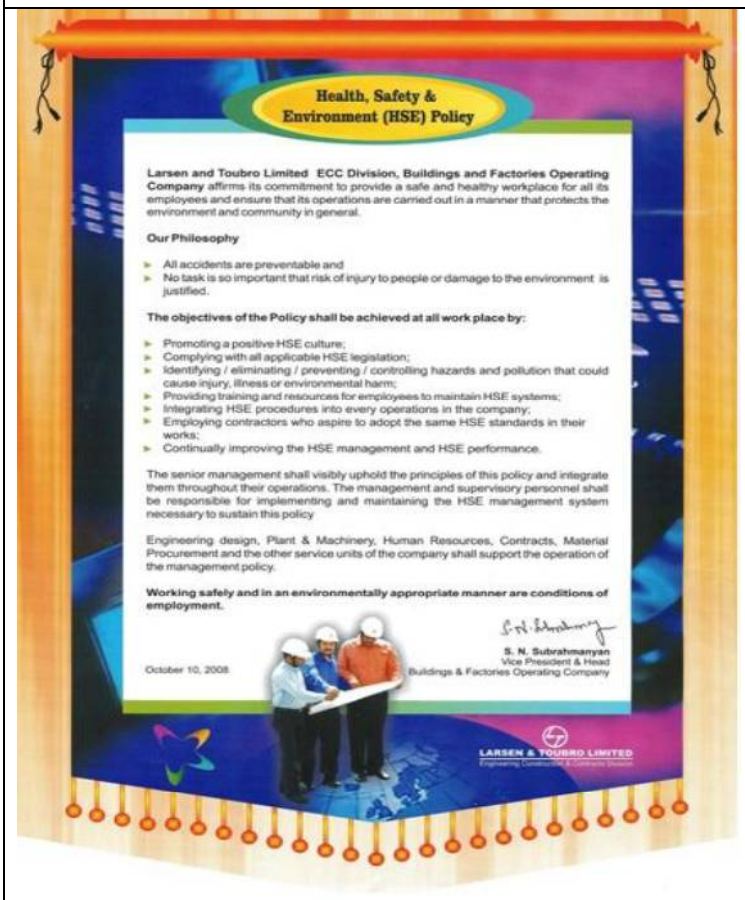
You will be presented with a series of statements on the following pages about health and safety. You should indicate your response by ticking the appropriate box.

Please tick appropriate box	**Strongly Agree**	**Agree**	**Neither Agree/Nor Disagree**	**Disagree**	**Strongly Disagree**
1) Management operates an open door policy on safety issues					
2) Safety is the number one priority in my mind when completing a job.					
3) Co-workers often give tips to each other on how to work safely					
4) Safety rules & procedures are carefully followed.					
5) Management clearly considers safety of employees of great importance.					
6) I am sure it is only a matter of time before I am involved in an accident.					
7) Sometimes I am not given enough time to get the job done safely.					
8) I am involved in informing					

management of important safety issues.					
9) Management acts decisively when a safety concern is raised.					
10) There is a good communication here about safety issues which affect me					
11) I understand the safety rules for my job					
12) It is important to me that there is continuing emphasis on safety.					
13) I am involved with safety issues at work					
14) This is a safer place to work than the other companies I have worked for					
15) I am strongly encouraged to report unsafe conditions					
16) In my workplace management turn a blind eye to safety issues					
17) Some safety rules and procedures do not need to be followed to get the job done safely					
18) I am rarely worried about being injured on the job.					
19) Management acts only after accidents have occurred					
20) I believe safety issues are not assigned a high priority					
21) Some health & safety procedures are not really practical					
22) Employees are not encouraged to raise safety concerns					
23) Personally I feel that safety issues are not the most important aspect for my job					
24) In my workplace the chances of being involved in an accident are quite large					

25) I do not receive praise for working safely					
26) Corrective action is always taken when management is told about unsafe practices					
27) Operational targets often conflict with safety measures					
28) My line manager/supervisor does not always inform me of current concerns and issues					
29) I can influence health & safety performance here					
30) Sometimes conditions here hinder my ability to work safely					
31) Safety information is always brought to my attention by my line manager/supervisor					
32) When people ignore safety procedures here, I feel it is none of my business.					
33) In my workplace management acts quickly to correct safety problems.					
34) I am clear about what my responsibilities are for Health & Safety					
35) Sometimes it is necessary to depart from safety requirements for productions sake					
36) A safe place to work has a lot of personal meaning to me.					
37) There are always enough people to get the job done safely					
38) In my workplace managers/supervisors show interest in my safety					
39) I am never involved in the ongoing review of safety.					
40) Management considers safety to be equally as important as production					
41) A no blame approach is used to persuade people					

acting unsafely that their behaviour is inappropriate					
42) Managers & supervisors express concern if safety procedures are not adhered to					
43) I cannot always get the equipment I need to get the job done safely					



Please tick the appropriate box	No	Sometimes	Yes
1. Do you think the company really means this?			
2. Do you think your immediate colleagues believe the company really means this?			
3. Do you think everyone in the organisation thinks the company really means this?			

Further Comments:

Do you have any other comments about Environment, Health and Safety in your Workplace?

APPENDIX 3

SAMPLE DIRECT OBSERVATION SAFETY CHECKLIST

Name of the Person carrying out this Observation: _____

Date Observation conducted: _____ Location: _____

INDICATE EITHER: S = Safe; U = Unsafe; N/A = Not Applicable

EXCAVATION		**SCAFFOLDS**	
Is there a safe access/egress provided to the excavation?		Are all standards provided with proper base plates?	
Are materials, spoil, and plant stored away from edge of excavation to reduce the chance of a collapse?		Are all ledgers, braces and struts in proper position?	
Is there provision for Dewatering facilities?		Is the scaffold secured to the building or structure in enough places to prevent collapse?	
Are there a proper barricade/ fencing and display of Danger sign by way of red tape/light/hand rails?		Are there double guard rails and toe boards or other suitable protection to prevent falling from edge?	
Is the earth being cut from the top and ensuring no undercutting is being done?		Is there a lock pin in place and secure?	
Is there adequate support for the excavation, or has it been sloped or battered back to a safe angle?		Is there proper access in and around the scaffold?	
Are there properly secured stop blocks provided to prevent tipping vehicles falling in?		Is there a safe access and egress to the working platform in the scaffold?	
-		Is Provision for anchoring full body harness – lanyards to be tied to life line?	
Percentage of Safe Observations seen		**Percentage of Safe Observations seen**	
ELECTRICAL SAFTEY		PLANT & MACHINERY	
Are all electrical connections routed through RCCB/ELCB & checked regularly?		Are the right tools or machinery being used for the right job?	
Is there proper weather protection for electrical installations?		Are all dangerous parts guarded, e.g. gears, chain drives, etc.	
Is there proper joining of cables and usage of plug tops?		Electrical cords inspected & have all prongs intact?	
Is there necessary LOTO adopted for maintenance?		Are tools and machinery maintained in good repair and are all safety devices operating properly?	
Are there sufficient numbers of qualified electricians available at site?		Are all operators trained and competent?	
Are cable and leads protected from damages?		-	
Percentage of Safe Observations seen		**Percentage of Safe Observations seen**	

CRANE SAFETY		**CRANE SAFETY**	
The crane suitable for job?		Are arrangements being made to make sure that the driver can see the load or a signaler been provided for help?	
Has the lift been planned properly?		Are people stopped from working or walking beneath a raised load?	
Is the crane on firm level base; are the riggers properly set?		Does the crane have a current report of thorough examination and record of inspection?	
Are the crane driver and signaler trained and competent?		Has the slinger being properly trained to attach the loads?	
Is the load secure?		-	
-		**Percentage of Safe Observations seen**	
LADDER SAFETY		**CONCRETING**	
Are ladders in good condition?		Is there a practice of checking formwork by supervisory personnel prior to starting concreting?	
Are ladders rested against a solid		Are there authorized banks men available?	
Are they secured to prevent them from slipping sideways or outwards?		Is there effective communication in place amongst the concrete pipeline operators?	
Do ladders raise a sufficient height above their landing place? If not suitable hand holds are being provided?		Is there a ball catcher in place during ball passing?	
Are ladders positioned so that they don't have to over stretch?		-	
Is there a proper slope of the ladder i.e. 1:4?		-	
Percentage of Safe Observations seen		**Percentage of Safe Observations seen**	
HOT WORK		**TRAFFIC VEHCLES & PLANT**	
Are there proper storage facilities for empty and full gas cylinders?		Are vehicles and pedestrians kept apart? If not do you separate them as much as you can and use barriers?	
Are the cylinders transported in trolleys?		Is there adequate clearance around slewing vehicles?	
Are flash back arrestors provided?		Is reversing being avoided e.g. by using a one way system or if not, are properly trained signalers used?	
Is there proper grounding of welding equipment?		Are vehicles and plant properly maintained e.g. doing the steering lights, handbrake, and foot brake properly work?	
Are fire extinguishers provided within 3 metres where hot work is being carried out?		-	
Is the area around hot work free from combustible material?		-	
Is the condition of cables, cable joints, electrode holder, regulator, etc. proper?		-	
Percentage of Safe Observations seen		**Percentage of Safe Observations seen**	

ACCESS ON SITE		PPE COMPLIANCE	
Can everyone get to their workplace safely and work there safely?		Are helmet, safety shoe and safety vest being worn inside the site?	
Are access routes in good condition and clearly signposted?		Is fall protection equipment being used correctly(double lanyards, securing lanyards, fall arrestor)	
Are edges which people could fall provided with double guard rails or suitable edge protection?		Are specified safety goggles being worn for welding/gas cutting/ grinding works?	
Are holes protected with clearly marked and fixed covers to prevent falls?		Are shoulder pads being used while lifting rebar?	
Are temporary structures stable, adequately braced and not overloaded?		Is a safety glove being used while lifting rebars?	
Is lighting adequate, especially when work is being carried on after dark outside or inside buildings?		Are ear plugs being work in while carrying out high noise generating operations?	
Percentage of Safe Observations seen		**Percentage of Safe Observations seen**	

WORKING AT HEIGHT		HOUSE KEEPING	
Is there a safe access provided to the workplace?		Is the project work area clean and free from excess trash or debris?	
Are adequate arrangements made for working at height like lifeline, full body harness, fall arrestor etc.		Are the walkways and passageways clear of debris?	
Are hand tools and handling materials secured against accident fall?		Is there separate storage or scrap yards identified for waste dumping?	
Is height work cordoned and unauthorized entries checked?		Is water being sprayed on site to reduce dust emissions?	
Percentage of Safe Observations		**Percentage of Safe Observations**	
FIRE PREVENTION/PROTECTION		**HYGIENE**	
Are fire prone operations, substances properly identified and necessary fire prevention and control measures implemented?		Are there adequate toilet facilities for number of personnel working in site?	
Are separate storages being provided for flammable liquids, gases and solids?		Is there drinking water available in the site and work areas?	
Is there required quantity of fire fighting equipments available at site?		Are health & hygiene inspections conducted and observations recorded?	
Are fire fighting equipments checked and periodically recorded?		Is the labour colony maintained clean and tidy?	
Is there an emergency response plan in place?		Are campaigns and competitions being carried out for health awareness?	
Are mock fire drills being regularly carried out in site premises?		-	
Percentage of Safe Observations Seen		**Percentage of Safe Observations seen**	

ENVIRONMENT		**MISCELLANEOUS**	
Are waste materials segregated and disposed off in designated areas?		Is there a first aid box with medicines and maintained properly?	
Is the waste water discharged without harming the surrounding environment?		Is the validity of medicines checked properly?	
Is there proper spill control and collection of oil at the site?		Are safety boards and safety promotional materials in place around the site?	
Are there adequate dust control measures in place?		Is there provision of emergency vehicle in place?	
Percentage of Safe Observations seen		**Percentage of Safe Observations seen**	

Signature of Person carrying out the Observation:

Approved by: _____ _____ _____

HSE CULTURE AT CONSTRUCTION SITE OF A PROJECT

DIRECT OBSERVATION CHECKLIST REPORT

ASSESSMENT ELEMENTS	SCORE - % PERCENTAGE SAFE OBSERVATION				AVERAGE SCORE FOR THE ELEMENT
	TOWER A	TOWER B	TOWER C	MLCP	
Excavation					
Scaffolds					
Electrical Safety					
Plant & Machinery					
Crane Safety					
Ladder Safety					
Concreting					
Hot Work					
Traffic Vehicles& Plant					
Access on Site					
PPE Compliance					
Working at Height					
House Keeping					
Fire Prevention					
Hygiene					
Environment					
Miscellaneous					
Score of the Areas					

AVERAGE SCORE FOR THE PROJECT:

Signature of Person carrying out the Observation:

Approved by: _____ _____ _____

Examples for Questioners:

Sr.No	**ERS Recommendations/ suggestions**			**Comments**
	Port & Terminal	**CLOSED (YES/NO)**	**Target date**	**Any other comments**
1	**Self Contained Breathing Apparatus**	**Yes**	Closed	All 12 SCBA equipment are tested and found OK by Vijay sabre. Only CCOE certificates for cylinders are pending.
1.1	No bench test done. No test certificates available for 300 bars cylinders. O-rings and pressure gauges in some equipment found damaged. Whistle for low pressure was blowing at more than 50 bars. Wise grip was found damaged due to use of spanners.	**No**	Sep-30	We are looking for space for permanent set of SCBA compressor filling systematic new warehouse.
1.2	SCBA compressor requires running log. Tripping set to 280 and not 300 bar. Concern on the breathing air filter condition. Water bath required to reduce temp. Of cylinder. Fill each cylinder in about 15 minutes	**No**	Dec-31	We will explore return/ replace the suits with other equipments to Vijay fire keeping 2 suits with us.
1.3	Fire proximity suits- 24 aluminised proximity suits are not required as we have 6 gold firemen suits. Goes against the philosophy of contain and control.			
2	**Foam Branches**	**YES**	Closed	Agreed
2.1	Hazira LNG has no need to work with foam branches with low expansion foam.	**No**	Oct-31	Our system is designed for 7 bars plus pressure and we cannot use medium expansion foam. We will discuss with the supplier.
2.2	AFFF foam cannot be used to generate Medium Expansion foam at 7 bar network pressure	**No**	Oct-31	Agreed. We are discussing with Foam compound suppliers. The whole foam philosophy has to be reviewed
2.3	Knowledge of foam management and application is required. Foam de-composition rate and quality to tested frequently.	**No**	Dec-31	We will talk to the Foam cart / trolley suppliers
2.4	AFFF foam can corrode the Mild steel foam cart body because of its acidic properties	**No**	Sep-30	Proper marking labeling of foam compound to be done to identify correct foam
2.5	There is possibility of mixing of 2 different types of foams	**No**	Sep-30	Will be shifted new warehouse designated area
2.6	Foam trailers, tractor and drums to be kept			

	under shed			
3	**Fire Couplings**	**YES**	Sep-19	We have replaced all hydrants and 50% mobile equipment couplings.
3.1	Storz type fire couplings mismatching. Change to instantaneous types.	**YES**	Sep-30	Ops is doing the survey with the help of response personnel. Ths is being pursued by HSE dept also.
3.2	Portable fire equipment are not installed as per the Risk assessment and safety equipment list given by projects			Oil spill contingency plan is in place.
4	**Fire extinguishers**		Sep-30	Ops is doing the survey with the help of response personnel. Ths is being pursued by HSE dept also.
4.1	Placements of extinguishers need to be re-assessed as per location. There is mismatch in what is provided and what is required.		Closed. To be checked during field training.	We discussed with refilling contractor. Action is taken and observation is corrected.
4.2	Re-filled extinguishers are failing. Safety pin had been wired into place which will prove difficult to come out during emergency.		Nov-30	We discussed with refilling contractor. Action is taken and observation is corrected.
4.3	Also need to check powder quality as well as Nitrogen quality. One multipurpose type powder (such as Olfex) should be used instead of many.(Sodium Bi-carbonate, Ammonium phosphate)			
5	**Training Chamber**		Dec-31	To be addressed
5.1	Add one more container for SCBA drill for long duration training. Develop very good SCBA drill chambers in addition to what we have.			
6	**Fire & Rescue equipment checks**		Closed	Already started
6.1	2 wwkly, Monthly, annual checks to be set in			
7	**Training needs/ Pre-incident analysis**		Nov-30	Training manager has already visited M/s GAIL to explore possibility of live gas fire training and developing inhouse training program for newcomers as well as refreshers

7.1	Emergency response Training needs analysis to be developed for staff for a) each position b) as per personal needs. Demonstrable, repeatabity competence level to be achieved.		Sep-30	16 plans are there. We will re-arrange fire equipment jointly with Operations.
7.2	Pre-Incident Plans to match with Fire equipment availbility in the vicinity			
8	**Drills/exercises**		Closed	Drill plan is followed up.
8.1	Regular practise drills to be conducted		Sep-30	Emergency responders in shifts already report to operation. Joint drills will help
8.2	Communication between Emergency responders and operation to be smoothened.		Mar-31	To be explored
8.3	Tugboat Fire water manifold should be shifted to Tugboat jetty itself			

Hazards and Effects Register:

Table 1: Biological Aspects

1. Hazard Group		2. Hazard	Methanol
3. Top Event			
Exposure to			
4. Location & Acceptance Criteria			
Operations, Area Maintenance Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Irritant to skin, eyes, respiratory tract. cough, dizziness, headache and nausea. Ingestion: possible blindness, death.			**B4**
Chronic: Dermatitis, persistent or recurring headaches, impaired vision. Blood changes, potential liver & kidney damage.			**B4**
6. Threats/Exposure Route			
Exposure Route: Inhalation of accidentally released material, e.g. due to: - Damage to a drum/pump - Line/tubing leak - Drum exposure to sun light			
7. Existing Barriers			
- Training & raising awareness - Standing Instruction & operating procedure - PTW - Dedicated chemical sheds for storing drums			
8. Existing Recovery Preparedness Measures			
- Communications - Buddy system - PPE - Safety Showers (including activation alarm) & Eye Washers			

1. Hazard Group		2. Hazard	Food & Drink Contaminated with Micro-organism

3. Top Event

Exposure to all

4. Location & Acceptance Criteria

Entire facility.

Exposure needs to be below exposure limit

5. Risk Assessment	Risk Ranking
Acute: Food poisoning (nausea, vomiting, diarrhoea), Hepatitis A, amoebic dysentery.	E3
Chronic: Carrier of disease without having symptoms e.g. typhoid.	C2

6. Threats/Exposure Route

- Consumption of contaminated cooking water
- Consumption of deteriorated food
- Cross contamination raw/cooked food
- Infected kitchen staff/poor hygiene

7. Existing Barriers

Salmonella, campylobactor, e-coli.

- Alternative sources of water
- Good water supply
- Chlorination of water
- Adequate storage capacity
- Food purchased from reputable suppliers only
- Storage & stock control procedures
- Training & experience of (kitchen) staff
- Discard left-over food
- Hygiene/housekeeping procedures in kitchens
- Food served at appropriate temperatures
- Regular kitchen inspections
- Regular medical checks for kitchen staff
- Appropriate clothing/head covering
- Food sampling/analysis
- Separate utensils for raw and cooked food

8. Existing Recovery Preparedness Measures

- Procedures for identifying the source
- Clinic / First Aid
- Medevac arrangements

1. Hazard Group		2. Hazard	Air Conditioning Systems (Moulds etc.)
3. Top Event			
Exposure to all			
4. Location & Acceptance Criteria			
Entire facility. Exposure needs to be below exposure limit where one exists and/or below any limit set in any of the facility.			
5. Risk Assessment			**Risk Ranking**
Acute: Irritation to respiratory tract, allergenic reactions.			**A2**
Chronic: Damage to lungs and kidneys.			**A3**
6. Threats/Exposure Route			
Moulds, bacterial & fungal growth.			
7. Existing Barriers			
- Regular maintenance of HVAC systems			
8. Existing Recovery Preparedness Measures			
- RAMS Clinic			

1. Hazard Group		2. Hazard	Viruses and Bacteria Contained in Sewage.
3. Top Event			
Exposure to all			
4. Location & Acceptance Criteria			
Sewage Treatment Plant Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Immediate effects from pathogens in raw sewage material will depend on the pathogen, such as Tetanus, Typhoid.			**B2**
Chronic: Long term hazards such as hepatitis and other similar organisms.			**B3**
6. Threats/Exposure Route			
Bacteria/Germs, Hepatitis etc.. Anywhere exposure to raw sewage is possible.			
7. Existing Barriers			
- Good housekeeping - Raising awareness			
8. Existing Recovery Preparedness Measures			
- Clinic			

Table 2: Chemical Aspects

1. Hazard Group		2. Hazard	Mercury
3. Top Event			
Exposure to			
4. Location & Acceptance Criteria			
Maintenance Department Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Irritation and burns to eye, skin and respiratory tract.			**B1**
Chronic: CNS damage. May cause muscle tremors, personality/behaviour changes, memory loss, metallic taste, loosening of the teeth, digestive disorders, skin rashes, brain damage and kidney damage. Can cause skin allergies and accumulate in the body.			**B4**
6. Threats/Exposure Route			
Crushing fluorescent tube lights Exposure Route: Inhalation, dermal absorption through:			
7. Existing Barriers			
- Training and raising awareness - PTW system - Task Risk Assessment - Method Statement for work carried out			
8. Existing Recovery Preparedness Measures			
- Work only in well-ventilated areas - Health checks			

1. Hazard Group		2. Hazard	Corrosion Inhibitors
3. Top Event			
Exposure to all working personnel			
4. Location & Acceptance Criteria			
Operations, Area Maintenance Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Corrosive/irritant effects to eyes, skin, respiratory tract, (possible nervous system effects).			**B3**
Chronic: Dermatitis, increased potential for cancer (dependent on the components).			**B4**
6. Threats/Exposure Route			
Exposure Route: Inhalation or splash/dermal absorption of corrosion inhibitor. Threats: - Damage to a drum/pump - Line/tubing leak - Drum exposure to sun light - Loss of injection rate control			
7. Existing Barriers			
- Training & raising awareness - Standing Instruction & operating procedure - PTW			
8. Existing Recovery Preparedness Measures			
- Communications - Buddy system - PPE - Safety Showers & Eye Washers			

1. Hazard Group		2. Hazard	Hydrocarbons, Lubricating & Seal Oil
3. Top Event			
Exposure to all working crew			
4. Location & Acceptance Criteria			
Operations, Area Maintenance, Maintenance Department Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Irritation to eye and skin.			B1
Chronic: Dermatitis, Intestinal damage.			B2
6. Threats/Exposure Route			
Used for pumps, turbines and compressors. Exposure Route: Inhalation or splash/dermal absorption of lubricating & seal oil Threats: - Human errors - Hot fume inhalation during filling			
7. Existing Barriers			
- Training & raising awareness - Standing Instruction & operating procedure - PTW			
8. Existing Recovery Preparedness Measures			
- Communications - PPE - Safety Showers (including activation alarm) & Eye Washers - Emergency response			

1. Hazard Group		2. Hazard	Methanol
3. Top Event			
Exposure to			
4. Location & Acceptance Criteria			
Operations, Area Maintenance Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Irritant to skin, eyes, respiratory tract. cough, dizziness, headache and nausea. Ingestion: possible blindness, death.			**B4**
Chronic: Dermatitis, persistent or recurring headaches, impaired vision. Blood changes, potential liver & kidney damage.			**B4**
6. Threats/Exposure Route			
Exposure Route: Inhalation of accidentally released material, e.g. due to: - Damage to a drum/pump - Line/tubing leak - Drum exposure to sun light			
7. Existing Barriers			
- Training & raising awareness - Standing Instruction & operating procedure - PTW - Dedicated chemical sheds for storing drums			
8. Existing Recovery Preparedness Measures			
- Communications - Buddy system - PPE - Safety Showers (including activation alarm) & Eye Washers			

1. Hazard Group		2. Hazard	Hydrocarbons - NGL
3. Top Event			
Exposure to working crew			
4. Location & Acceptance Criteria			
Operations, Area Maintenance Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Moderately irritating to eyes, skin; causing redness, drying of skin.			**A1**
Chronic: May affect the respiratory and central nervous system.			**A3**
6. Threats/Exposure Route			
Exposure Route: Inhalation, splash or dermal absorption where NGL is handled or sampled.			
7. Existing Barriers			
- Closed sampling system - Procedures - Training and raising awareness			
8. Existing Recovery Preparedness Measures			
- PPE - RAMS Clinic			

1. Hazard Group		2. Hazard	Hydrocarbons, LPG
3. Top Event			
Exposure to			
4. Location & Acceptance Criteria			
Operations, Area Maintenance Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Dizziness, impairment			**C2**
Chronic: None known			
6. Threats/Exposure Route			
Exposure Route: Inhalation, anywhere LPG is handled			
7. Existing Barriers			
- Training and raising awareness - Procedures			
8. Existing Recovery Preparedness Measures			
- PPE - Safety showers (including activation alarm) and eye wash - Clinic			

1. Hazard Group		2. Hazard	Cleaners/Degreasers
3. Top Event			
Exposure to			
4. Location & Acceptance Criteria			
Operations, Area Maintenance, Maintenance Department Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Irritation to eyes, skin and respiratory tract.			**D2**
Chronic: Potential liver & kidney damage. Dependent on the type used.			**B3**
6. Threats/Exposure Route			
Exposure Route: Inhalation or dermal absorption, anywhere a worker is using chemical materials to clean equipment.			
7. Existing Barriers			
- Training and raising awareness - Procedures - Availability of MSDS			
8. Existing Recovery Preparedness Measures			
- PPE - Safety showers (including activation alarm) and eye wash - Clinic			

1. Hazard Group		2. Hazard	Hydrogen Sulphide - Low Level Exposures
3. Top Event			
Exposure to			
4. Location & Acceptance Criteria			
Lean Gas Station, the 'Midpoint' and Booster station. Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Irritation to eyes and respiratory tract.			**D2**
Chronic: None known.			
6. Threats/Exposure Route			
Exposure Route: Inhalation. Anywhere H_2S is present, in particular near places where fugitive emissions of gas can occur.			
7. Existing Barriers			
- Training and raising awareness - Procedures			
8. Existing Recovery Preparedness Measures			
- H_2S detection in process areas - Personal H_2S detectors - PPE - Clinic			

1. Hazard Group		2. Hazard	Welding Fumes

3. Top Event

Exposure to working crew

4. Location & Acceptance Criteria

Maintenance Department

Exposure needs to be below exposure limit

5. Risk Assessment	Risk Ranking
Acute: Eye, nose throat irritation, Metal fume fever (fever, chills, headache).	C2
Chronic: Dependent on material being welded and rods used. Potential nerve damage and lung problems.	B4

6. Threats/Exposure Route

Construction and metal fabrication / repair, welding toxic metals (galvanized steel, cadmium coated steel), metal cutting, grinding.

Exposure Route: Inhalation during welding stainless steel, manganese containing steel and when using welding rods.

Threats:

- Fumes from metal/rods

7. Existing Barriers

- PTW with method statement/risk assessment
- Training and raising awareness
- PPE, including on-line breathing apparatus
- Inspection & certification of equipment
- Barricades and warning signs
- Working intervals for the welders

8. Existing Recovery Preparedness Measures

- Exhaust ventilation (general or local)
- Rescue procedure
- First aid/medevac if required

1. Hazard Group		2. Hazard	General Chemical Irritants
3. Top Event			
Exposure to			
4. Location & Acceptance Criteria			
Entire field Facility Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Irritant to exposed part of the body, dependent on the material properties			**D2**
Chronic: Dermatitis and potentially chronic problem, dependent on the material properties.			**B2**
6. Threats/Exposure Route			
Commercial products, like bleaching agents and detergents and other water treatment chemicals. Exposure Route: Inhalation, splash or dermal absorption. Threats: - Accidental release of chemical - Release during normal operations use of chemical - Release of chemical during maintenance			
7. Existing Barriers			
- Information on chemicals used - Chemical handling system - Chemical handling procedures - Maintenance procedure - PTW - Training and raising awareness			
8. Existing Recovery Preparedness Measures			
- PPE - Safety Showers (including activation alarm) and Eye Washers - Buddy system - Medical check-ups - First Aid/ Clinic			

1. Hazard Group		2. Hazard	Sulphuric Acid
3. Top Event			
Exposure to working crew			
4. Location & Acceptance Criteria			
Operations, Maintenance Department Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Corrosive to skin and eyes. Respiratory irritant, may cause pulmonary oedema.			**B2**
Chronic: Lung damage (Laryngeal/pulmonary oedema, Bronchitis, Pneumonitis), known carcinogen, erosion of teeth.			**B4**
6. Threats/Exposure Route			
Used for water treatment Exposure Route: Inhalation, splash or dermal absorption. Threats: - Spills - Fumes			
7. Existing Barriers			
- Chemical handling procedures - Training and raising awareness			
8. Existing Recovery Preparedness Measures			
- PPE - Safety Showers (including activation alarm) and Eye Washers - First Aid/ RAMS Clinic			

1. Hazard Group		2. Hazard	Caustic Soda
3. Top Event			
Exposure to			
4. Location & Acceptance Criteria			
Operations, the Reverse Osmosis Units Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Corrosive/irritant to skin & eyes.			**C3**
Chronic: Potential blindness.			**A4**
6. Threats/Exposure Route			
Exposure Route: Inhalation or splash. Most likely causes are spills (e.g. during mixing of material) and leaks.			
7. Existing Barriers			
- Chemical handling procedures - Training and raising awareness			
8. Existing Recovery Preparedness Measures			
- PPE - Safety Showers (including activation alarm) and Eye Washers - First Aid/ Clinic			

1. Hazard Group		2. Hazard	Hydrocarbons - Low Level Gaseous Hydrocarbons
3. Top Event			
Exposure to			
4. Location & Acceptance Criteria			
Entire field Facility Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Headaches, irritation.			**E1**
Chronic: None known.			
6. Threats/Exposure Route			
Various hydrocarbons emitted in low concentrations. Exposure Route: Inhalation. Threats: - Small leaks - Vents and fugitive emissions (e.g. from glands)			
7. Existing Barriers			
- Procedures - PTW			
8. Existing Recovery Preparedness Measures			
- PPE - RAMS Clinic			

1. Hazard Group		2. Hazard	Sodium Hypochlorite
3. Top Event			
Exposure to			
4. Location & Acceptance Criteria			
Operations, in the Reverse Osmosis Unit Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Irritant/corrosive to skin and eye			**C2**
Chronic: Pulmonary oedema			C3
6. Threats/Exposure Route			
Exposure Route: Inhalation or skin contact Threats: - Improper handling			
7. Existing Barriers			
- Procedures - PTW			
8. Existing Recovery Preparedness Measures			
- PPE - Clinic			

1. Hazard Group		2. Hazard	Triethylene Glycol
3. Top Event			
Exposure to			
4. Location & Acceptance Criteria			
Area Maintenance Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Irritant to skin and eye.			**C1**
Chronic: None known.			
6. Threats/Exposure Route			
Handling glycol containing transmitters Exposure Route: Splash, dermal absorption. Threats: - Accidental damage to equipment - Line/tubing leak			
7. Existing Barriers			
- PTW - Standing Instructions & operating procedures - Training and raising awareness			
8. Existing Recovery Preparedness Measures			
- Communications - PPE - Safety Showers (including activation alarm) & Eye Washers - RAMS Clinic			

1. Hazard Group		2. Hazard	Commercial Greases
3. Top Event			
Exposure to working crew			
4. Location & Acceptance Criteria			
Area Maintenance, Maintenance Department Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Irritant to skin			**C1**
Chronic: Dermatitis, cracking of the skin			**C1**
6. Threats/Exposure Route			
Using greases for bearings Exposure Route: Dermal (absorption) Threats: - Unprotected use			
7. Existing Barriers			
- PTW - Standing Instructions & operating procedures - Training and raising awareness			
8. Existing Recovery Preparedness Measures			
- PPE - Clinic			

1. Hazard Group		2. Hazard	Paint, Coatings, Various
3. Top Event			
Exposure to			
4. Location & Acceptance Criteria			
Maintenance Department, Area Maintenance Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Irritation to eyes, skin and respiratory tract. Drowziness, dizziness.			**D2**
Chronic: Defatting of skin. Potential kidney, liver, CNS problems. Possibly sensitization if isocyanates used.			**D3**
6. Threats/Exposure Route			
Working with paint and coating materials, particularly those containing solvents. Exposure Route: Inhalation, but also splash or dermal absorption. Most likely threats: - Spray painting - Spills			
7. Existing Barriers			
- Use of less hazardous paints (e.g. water based) - Procedures - Training and raising awareness			
8. Existing Recovery Preparedness Measures			
- PPE - Clinic / First Aid			

1. Hazard Group		2. Hazard	Scale Inhibitors
3. Top Event			
Exposure to working crew			
4. Location & Acceptance Criteria			
Operations, in the Reverse Osmosis Units Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Irritation and burns to eyes and skin.			**D1**
Chronic: None known.			
6. Threats/Exposure Route			
Hypersperse Exposure Route: Inhalation or splash. Most likely threats: - Spills during handling and preparation of chemical - Line/tubing leak			
7. Existing Barriers			
- Standing Instructions & operating procedures - PTW - Training and raising awareness			
8. Existing Recovery Preparedness Measures			
- Buddy system - Communications - PPE - Safety Showers (including activation alarm) and Eye Washers			

1. Hazard Group		2. Hazard	Aluminum Salts
3. Top Event			
Exposure to working personnel			
4. Location & Acceptance Criteria			
Operations, Area Maintenance Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Mechanical irritation to the eyes, skin and respiratory tract.			**C2**
Chronic: Loss of lung function.			**A2**
6. Threats/Exposure Route			
Exposure Route: Inhalation. Threat: Manual handling of molecular sieves/desiccants			
7. Existing Barriers			
- Procedures - Training and raising awareness			
8. Existing Recovery Preparedness Measures			
- PPE - Clinic			

1. Hazard Group		2. Hazard	Nitric Acid
3. Top Event			
Exposure to working personnel			
4. Location & Acceptance Criteria			
Operations, in the Reverse Osmosis Units Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Corrosive to skin and eyes			**B3**
Chronic: Acute pneumonitis, pulmonary oedema			**B3**
6. Threats/Exposure Route			
Exposure Route: Inhalation/Splash Threat: - Improper handling - Unprotected use			
7. Existing Barriers			
- Procedures - Training and raising awareness			
8. Existing Recovery Preparedness Measures			
- PPE - Clinic			

1. Hazard Group		2. Hazard	Solvents and Paint Thinners

3. Top Event

Exposure to working crew

4. Location & Acceptance Criteria

Maintenance Department, Area Maintenance

Exposure needs to be below exposure limit

5. Risk Assessment	Risk Ranking
Acute: Irritation to skin, eyes and respiratory system.	**D2**
Chronic: Defatting of skin. Adverse effects on kidney, liver & CNS. Particularly with certain solvents	**B3**

6. Threats/Exposure Route

Exposure Route: Inhalation, splash or dermal absorption.

Most likely threats:

- Contact during painting
- Spill

7. Existing Barriers

- Training and raising awareness

8. Existing Recovery Preparedness Measures

- PPE
- Clinic

1. Hazard Group		2. Hazard	Silica Gel
3. Top Event			
Exposure to handling personnel			
4. Location & Acceptance Criteria			
Area Maintenance Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Irritation to eyes, skin and respiratory tract			**C1**
Chronic: Fibrogenic			**C2**
6. Threats/Exposure Route			
Exposure Route: Inhalation Most likely threats: - Working with turbines/compressors			
7. Existing Barriers			
- Training and raising awareness			
8. Existing Recovery Preparedness Measures			
- PPE - Clinic			

1. Hazard Group		2. Hazard	Triorthocresyl Phosphate – Component of Aeroshell 500

3. Top Event

Exposure to handling personnel

4. Location & Acceptance Criteria

Operations, Area Maintenance

Exposure needs to be below exposure limit

5. Risk Assessment	Risk Ranking
Acute: Causes irritation to the skin, eyes and respiratory tract.	C2
Chronic: Affects central & peripheral nervous systems.	C3

6. Threats/Exposure Route

Using or adding oil containing tricresyl phosphate. Used as component in aviation fuel.

Exposure Route: Inhalation, splash or dermal absorption; most likely route is hot fume inhalation during filling.

7. Existing Barriers

- Engineering modifications
- Standing Instructions & operating procedures
- Training and raising awareness
- PTW
- MSDS

8. Existing Recovery Preparedness Measures

- Communications
- PPE
- Clinic / First Aid
- Safety Showers (including activation alarm) & Eye Washers

1. Hazard Group		2. Hazard	Sewage Sludge
3. Top Event			
Exposure to			
4. Location & Acceptance Criteria			
Sewage Treatment Plant Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Immediate effects from possible chemicals in raw sewage material will depend on the chemical			**A2**
Chronic: Long term hazards dependent on the chemical in the sewage			**A3**
6. Threats/Exposure Route			
Working in the Sewage Treatment Plant Exposure Route: Inhalation, splash or dermal absorption; most likely route is hot fume inhalation during filling.			
7. Existing Barriers			
- Standing Instructions & operating procedures - Training and raising awareness - PTW			
8. Existing Recovery Preparedness Measures			
- Communications - PPE - Clinic / First Aid - Safety Showers (including activation alarm) & Eye Washers			

1. Hazard Group		2. Hazard	Pesticides
3. Top Event			
Exposure to			
4. Location & Acceptance Criteria			
Camp (Housing Complex). Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: May cause eye, skin, lung irritation. Dependent on the type of pesticide used.			**B2**
Chronic: Possible nerve kidney, lung damage. Dependent on the type of pesticide used.			**B3**
6. Threats/Exposure Route			
Neocidol, Solfac. Exposure Route: Inhalation, splash or dermal absorption. Most likely route is through spraying/fogging of pesticide.			
7. Existing Barriers			
- Training and raising awareness - Procedures			
8. Existing Recovery Preparedness Measures			
- PPE - Clinic			

1. Hazard Group		2. Hazard	Soot Remover
3. Top Event			
Exposure to working crew			
4. Location & Acceptance Criteria			
Operations Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Irritation to eyes, skin and respiratory tract (mucous membranes)			**B2**
Chronic: Dizziness, anaemia and methaemoglobinaemia			**A3**
6. Threats/Exposure Route			
Nalfleet Exposure Route: Inhalation, splash or dermal absorption.			
7. Existing Barriers			
- Training and raising awareness - Procedures			
8. Existing Recovery Preparedness Measures			
- PPE - Clinic			

1. Hazard Group		2. Hazard	Carbon Black (dust)
3. Top Event			
Exposure to working crew			
4. Location & Acceptance Criteria			
Area Maintenance Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Irritation to eyes, skin and respiratory tract			**A2**
Chronic: Respiratory effects, possible carcinogen (IARC-2B)			**A4**
6. Threats/Exposure Route			
Dust from carbon brushes in electrical installations. Exposure Route: Inhalation or skin contact			
7. Existing Barriers			
- Training and raising awareness - Procedures - PTW			
8. Existing Recovery Preparedness Measures			
- PPE - RAMS Clinic			

Table 3: Ergonomics

1. Hazard Group		**2. Hazard**	Work Mismatch, Physical Inability
3. Top Event			
Exposure to working personnel			
4. Location & Acceptance Criteria			
Operations, Area Maintenance, Maintenance Department Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Strains, sore muscles.			**C1**
Chronic: Permanent back & shoulder problems.			**C2**
6. Threats/Exposure Route			
This involves capabilities of workforce do not match requirements of the job. Most likely threat is twists and hurts.			
7. Existing Barriers			
- Accessibility - Design			
8. Existing Recovery Preparedness Measures			
- Buddy system - Clinic			

1. Hazard Group		2. Hazard	Manual Materials Handling
3. Top Event			
Exposure to working crew			
4. Location & Acceptance Criteria			
Entire Asab-0 facility. Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Musculoskeletal injury.			**C2**
Chronic: Musculoskeletal and repetitive strain injury.			**C3**
6. Threats/Exposure Route			
- Moving equipment in awkward areas - Handling heavy tools, heavy equipment boxes - Repetitive work involving frequent twisting			
7. Existing Barriers			
- Training & raising awareness			
8. Existing Recovery Preparedness Measures			
- Clinic			

1. Hazard Group		2. Hazard	Awkward Location of Workplaces & Machinery

3. Top Event

Exposure to working crew

4. Location & Acceptance Criteria

Operations, Area Maintenance, Maintenance Department

Exposure needs to be below exposure limit

5. Risk Assessment	Risk Ranking
Acute: Musculoskeletal injury.	C2
Chronic: Musculoskeletal and repetitive strain injury.	C3

6. Threats/Exposure Route

- Welding in awkward position, improper welding posture
- Difficult locations with poor access
- Hard to operate valves
- Increasing downtime (stress)

7. Existing Barriers

- Use of proper tools, such as pneumatic pump
- Portable ladder
- Awareness of risks, e-mails
- Corrective maintenance
- Project Management by Operations
- Provide permanent/portable access steps

8. Existing Recovery Preparedness Measures

- Buddy system/get assistance/teamwork
- Clinic, physiotherapy available
- Training Centre support

1. Hazard Group		2. Hazard	Video Display Units (VDU) (Typing, Mouse Operations, Screen Viewing)

3. Top Event

Exposure to working personnel

4. Location & Acceptance Criteria

Entire facility.
Exposure needs to be below exposure limit

5. Risk Assessment	Risk Ranking
Acute: Muscular discomfort, eyestrain.	D2
Chronic: Musculoskeletal injury; work-related upper limb disorders.	D3

6. Threats/Exposure Route

- Repeated & continued movements in a heavy VDU use
- Poor workplace setup for VDU work (e.g. new overview screens in Control Room)
- Insufficient space for the equipment & tasks
- Exposure to work with VDU's for more than 6 hours per day

7. Existing Barriers

- Training on working postures and work/rest cycles
- Use of more appropriate software
- Replace the furniture
- Training & raising awareness
- Reduction of number of employees in area
- Use of alternative areas of the building (for new employees)
- Reduce VDU exposure time

8. Existing Recovery Preparedness Measures

- Medical (inhouse) surveillance system
- Rehab program

1. Hazard Group		2. Hazard	On land transport, driving
3. Top Event			
Exposure to working crew			
4. Location & Acceptance Criteria			
Operations, Area Maintenance, Maintenance Department, Warehouse Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Sore muscles and cramps			**D1**
Chronic: Back, arm and shoulder problems			**B2**
6. Threats/Exposure Route			
- Repeated & continued movements during driving - Bad posture while driving			
7. Existing Barriers			
- Work/rest cycles - Training & raising awareness			
8. Existing Recovery Preparedness Measures			
- Clinic - First Aid			

1. Hazard Group		2. Hazard	Hand-Wrist (Grasping, pinching, holding, repetitive use)
3. Top Event			
Exposure to working crew			
4. Location & Acceptance Criteria			
Operations Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Soreness and irritation of arm joints			**C1**
Chronic: Chronic wrist, arm and shoulder problems.			**A3**
6. Threats/Exposure Route			
Where heavy tools and equipment are used / carried.			
7. Existing Barriers			
- Raising awareness			
8. Existing Recovery Preparedness Measures			
- Rehab program			

1. Hazard Group		2. Hazard	Lifting, Lowering, Carrying
3. Top Event			
Exposure to working crew			
4. Location & Acceptance Criteria			
Warehouse, Operations, Area Maintenance, Maintenance Department Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Back pain.			**C2**
Chronic: Chronic disk problems.			**C3**
6. Threats/Exposure Route			
Where heavy tools and equipment are used / carried.			
7. Existing Barriers			
- Raising awareness			
8. Existing Recovery Preparedness Measures			
- Rehab program			

Table 4: Physical Aspects

1. Hazard Group		2. Hazard	Noise – Impact Noise (Short Term)
3. Top Event			
Exposure to			
4. Location & Acceptance Criteria			
Operations, Area Maintenance, Maintenance Department Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Rupture of eardrum; acoustic trauma.			**B2**
Chronic: Permanent hearing damage.			**B4**
6. Threats/Exposure Route			
Working near noisy equipment with no/insufficient hearing protection, e.g.: - Adsorber Change-over - High velocity gas (unplanned flaring) - Steam leaks/high pressure air - Boiler start-up venting - Any other equipment			
7. Existing Barriers			
- Corrective maintenance - Safety signs - Training & raising awareness - Specific procedures (e.g. for depressurizing, venting)			
8. Existing Recovery Preparedness Measures			
- PPE - Annual Audiograms			

1. Hazard Group		2. Hazard	Heat from Sun and Hot Working Areas
3. Top Event			
Exposure to			
4. Location & Acceptance Criteria			
Entire field facility. Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Heat stroke leading to death (lesser symptoms: exhaustion, cramps, rash, fatigue).			**E3**
Chronic: Aggravating of existing conditions and decrease in fertility.			**B3**
6. Threats/Exposure Route			
Any outside work during the hot days.			
7. Existing Barriers			
- Engineering controls (e.g. arrangement of additional shade) - Awareness training for employees and supervisors - Changing or restricting working hours - Training & raising awareness			
8. Existing Recovery Preparedness Measures			
- Supply liquids for fluid replacement - Employee health & fitness - Buddy system - PPE - First aiders on every shift & rescue procedure, medevac - Clinic nearby			

1. Hazard Group		2. Hazard	Noise - Loud Steady Noise
3. Top Event			
Exposure to working crew			
4. Location & Acceptance Criteria			
Operations, Area Maintenance, Maintenance Department Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Temporary Threshold Shift.			**C3**
Chronic: Noise Induced Permanent Threshold Shift (NIPTS), Tinnitus.			**E3**
6. Threats/Exposure Route			
Working near noisy equipment with no/insufficient hearing protection.			
7. Existing Barriers			
- Corrective maintenance - Safety signs, contour maps, area demarcation - Training & raising awareness			
8. Existing Recovery Preparedness Measures			
- PPE - Annual Audiograms			

1. Hazard Group		2. Hazard	Dust, sand & Smoke
3. Top Event			
Exposure to			
4. Location & Acceptance Criteria			
Entire Asab-0 facility. Exposure needs to be below ACGIH exposure limit where one exists and/or below any limit set in any of the Volume 3 ADNOC Codes of Practice.			
5. Risk Assessment			**Risk Ranking**
Acute: Mechanical irritation to the eyes and respiratory system.			**D1**
Chronic: Long term lung problems. Increased possibility of asthma.			**B3**
6. Threats/Exposure Route			
- Wind/storm creating dust and smoke - Smoke from flares, furnaces - Unburnt flare material			
7. Existing Barriers			
- Reduce flaring - Vegetation - Standing instructions - Closed fencing			
8. Existing Recovery Preparedness Measures			
- PPE - Clinic			

1. Hazard Group		2. Hazard	Non-Ionising Radiation - Ultraviolet (UV)
3. Top Event			
Exposure to working crew			
4. Location & Acceptance Criteria			
Entire field facility. Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Skin burns, eye arc effects (temporary blindness).			**B2**
Chronic: Skin cancer, increased potential for cataracts.			**B4**
6. Threats/Exposure Route			
- Arc welding - Sunshine			
7. Existing Barriers			
- Machine design - Raising awareness - Area Separation - Welding Curtain			
8. Existing Recovery Preparedness Measures			
- PPE - Clinic			

1. Hazard Group		2. Hazard	Non-Ionising Radiation – Electromagnetic Fields (EMF)

3. Top Event
Exposure to

4. Location & Acceptance Criteria
Area Maintenance, Maintenance Department Exposure needs to be below exposure limit

5. Risk Assessment	Risk Ranking
Acute: None known.	
Chronic: Possible increased risk of leukemia.	**B3**

6. Threats/Exposure Route
- High voltage areas (e.g. 11 kVa, 33 kV motors) - Mobile communication equipment (e.g. walkie-talkies)

7. Existing Barriers
- Purchasing appropriate equipment - Procedures - Training & raising awareness

8. Existing Recovery Preparedness Measures
- Clinic

Table 5: Psychosocial Aspects

1. Hazard Group		**2. Hazard**	Work Planning Issues
3. Top Event			
Exposure to working personnel			
4. Location & Acceptance Criteria			
Entire Asab-0 facility. Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Impaired or unsafe performance			**B2**
Chronic: Psychological stress, depression, burn out, absenteeism.			**B3**
6. Threats/Exposure Route			
Homesickness, missing family and social events caused by working schedule.			
7. Existing Barriers			
- Regular sports competitions			
8. Existing Recovery Preparedness Measures			
- Communication with relatives - Get time for distraction - Recreation facilities/sport activities - Clinic - Emergency leave			

1. Hazard Group		2. Hazard	Personal Stress / Tension
3. Top Event			
Exposure to working personnel			
4. Location & Acceptance Criteria			
Entire Asab-0 facility. Exposure needs to be below exposure limit			
5. Risk Assessment			**Risk Ranking**
Acute: Stress, lack of attention.			**B2**
Chronic: High blood pressure; psychological stress; depression; burn out; absenteeism.			**B3**
6. Threats/Exposure Route			
- Workload/time constraints (after duty hours, shift lag, long working hours during upset/shutdown) - Management pressure (including improper use of authority, poor decision makers) - Job satisfaction/job changing - Unclear communications/too many rumours - Living on the job/away from home			
7. Existing Barriers			
- Transparency in policy - Open communications - Circulars with information - Question & answer sessions			
8. Existing Recovery Preparedness Measures			
- Improve lifestyle - Recreation facilities, cable TV, internet, etc. - Compensation procedure - On-call procedure			