KTI 160604

EMC MANAGEMENT & ENGINEERING PROCEDURE

1. GENERAL

The Contractor shall prepare, present and implement an EMC management plan, describing the specific requirements and procedures to check the EMC performance during the engineering, procurement, construction and commissioning phase of the project. Where applicable, the plan shall also address EMC interfacing aspects of new and existing installations, including cathodic protection systems. Additionally, due attention shall be paid to EMC maintenance aspects for earthing, bonding and over voltage protection as well as instructions for future modifications . The objective of the plan is to ensure optimum co-operation between the disciplines involved during the different phases of the project and thus to obtain EMC with minimum costs. The Contractor shall assign names and responsibilities of 'focal points' for each phase of the project. For further requirements with respect to project quality assurance, reference is made to special defined, the contents of which shall be complied with. The Principal shall approve the EMC management plan.

2. ENGINEERING

During the engineering phase, the Contractor shall subject the design of the project to an EMC review, covering at least the following aspects:

- a site survey, in particular when the new facilities will be located in or close to an existing plant area. EMC aspects of interfacing earthing and cabling with co-located plants shall be addressed ;
- identification of inadvertent (power lines, switchgear, lightning etc) and purpose built (civilian & military radio, TV and communications transmitters) EM sources and EM victims and assessment of possible compatibility problems. For this purpose, an EMC matrix evaluation is an appropriate tool;
- a review of EMC specifications of electrical and instrument equipment, including FAT results, where applicable;
- an EM zone allocation plan shall be made, addressing the EM levels of the plant areas;
- a review of standard EMC installation and mitigation measures as described in this KTI;
- for lightning prone areas, a risk assessment of critical parts of the installation where equipment damage due to direct strokes and EMP is expected and the specification of any additional EMC measures;
- The submission of proof to the Principal either by presenting EMC analysis results or by EMC test plan results that the project meets the requirements as specified in this KTI requirements.

2.1 Site survey

The Contractor shall carry out a site survey covering at least the following aspects:

- direct lightning strike probability assessment of the site according to the approach and base data of BS 6651;
- presence of fixed civilian and military TV, radio and communications transmitters on or in the vicinity

of the site. The transmitter power and frequency parameters as well as geographical separation shall be determined ;

NOTE: As described in (10), the electrical field strength can be estimated using the expression :

$$E = \frac{\sqrt{30 P_t G_t}}{r}$$

with E =electrical field strength *[V/m).* P =transmitter power [W] and r =distance between antenna and location under consideration [m].

- presence of significant mobile civilian and military radio and communication transmitters in the site vicinity with particular attention to airfields and ports;
- presence of overhead high voltage distribution lines;
- presence of local cable trenches and cable trunking ;
- soil resistivity and other soil properties for determination of earth electrode material and corrosion probability (e.g., salt content, acidity etc.);
- possible future presence of electromagnetic sources related to temporary construction works, e.g., arc welding of piping, power electronics of cranes, etc.

If local field strengths and disturbing potential cannot be estimated on the basis of power, voltage and current parameters, then the relevant electromagnetic parameters may be measured.
The results of the site survey shall be laid down in a site survey report, to be approved by the Principal.

NOTE: An example of an installation site survey checklist is given in Annex A (informative) of IEC 61000-5-1 .

2.2 EMC matrix evaluation

An EMC analysis consisting of a matrix evaluation shall be prepared and evaluated by the Contractor. In this analysis, EM sources and EM victims of the plant facilities are arranged in rows and columns and for each matrix element (source - victim combination) the emission and immunity levels, the coupling path, the EMI potential and the resulting consequences for procurement, construction and commissioning shall be evaluated. All potential EM sources and victims shall be addressed in the EMC matrix evaluation, including external sources like lightning, high voltage distribution lines, broadcast and mobile communications transmitters, and radar transmitters in coastal or airport areas.

NOTE: Equipment may be arranged in a matrix according to system configuration or Manufacturer's delivery,

e.g.,:

- Electrical power generating and distributing systems , including generator management systems ;
- Station Management Systems (SMS);
- Sensor, Signal, Control and Analog Monitoring System
- Distributed Control System (DCS);
- Instrument Protective System (IPS);

- Fire and Gas system (FGS);
- Telecommunication systems ;
- Security systems ;
- Utilities (lighting, air conditioning, water treatment);
- Installation of co-located plants.

Any specific apparatus or system may be an EM source as well as a possible victim of interference. The results of the EMC matrix evaluation shall be presented in an evaluation report reflecting the conclusions and specific follow-up during procurement, construction and commissioning. The Principal shall approve the matrix evaluation report.

Matrix Analysis Examples for submarine;

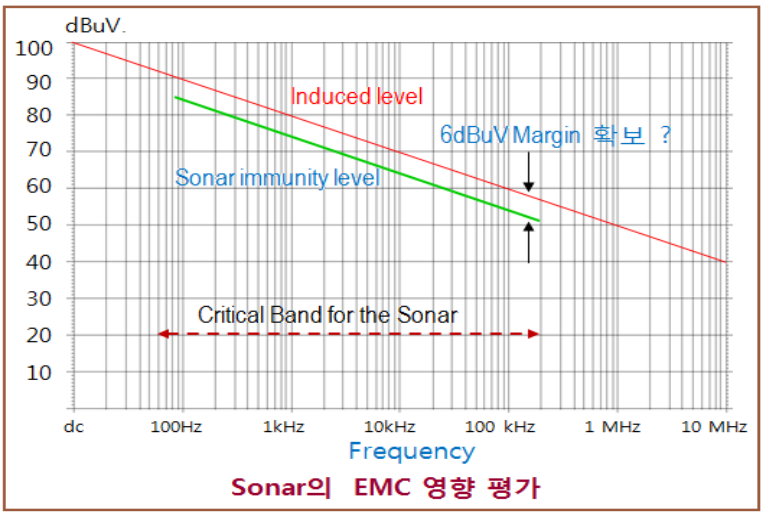
EM Sensitive's / Sources	1 Bow sonar	2 Side sonar	3 Torpedo controller	…
A. VVVF				
B. UPS				
C. SCR 위상 제어기기				
…				

1) EMC analysis between VVVF to Bow sonar(A-1)

- Conducted noise emission (MIL STD 461F, CE Test report or Test) = 35dBuV at 76Hz-200kHz
- Conducted immunity level for the beam forming type sensor(MIL STD 461F CS Test report or was given by the Sonar manufacture) = Max 29 dBuV at 76Hz-200kHz
- Margin calculation:

(Emission level - Susceptibility level)= 36dBuV - 29dBuV = 6dB

- Minimum Margin requirement on the system = 6dB
- Result : This result is satisfied the 6dB margin but need to reduce the VVVF conducted emission level or to increase the Sonar immunity level.



2.3 EM zone allocation

Further to IEC 61000-2-5, an EM zone allocation plan shall be made by the Contractor to ensure compatibility between EM levels of different types of equipment at different locations. For each EM level, a limited EM zone shall be defined in which a majority of equipment meets a particular EM level. All equipment located in the particular EM zone shall be specified with due regard being given to the corresponding emission and immunity levels. Two EM zones is the minimum for this approach, three EM zones is acceptable, but more than three EM zones shall only be used in exceptional cases, e.g., when very sensitive or very disturbing equipment is being installed.

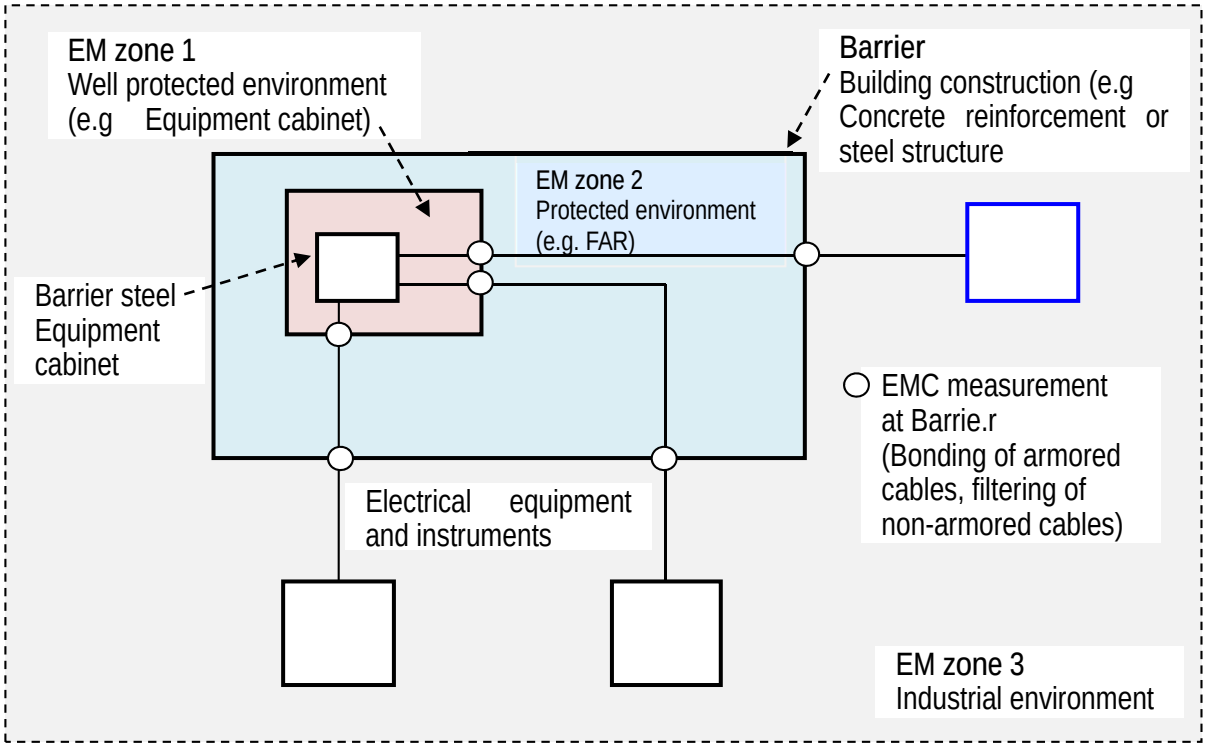


Figure 1. shows an example of (a part of) a typical EM zoning concept.

Boundaries between different EM zones shall be defined as building walls, equipment room walls, equipment cabinets and equipment enclosures . For uniformity and economic reasons, level 2 and level 3 equipment should be used. Level 1 and level 4/level X equipment shall only be used in exceptional

cases, as approved by the Principal.

NOTES: 1. Special laboratory equipment for use in analyzer houses may be very sensitive, meeting level 2 or even level 1 immunity requirements. This equipment should be installed in a shielded cabinet and due attention shall be given to bonding and filtering of interconnected cabling.

2. Large UPS systems meeting the EN 50091-2 product standard may have higher conducted emission limits than the generic industrial levels. In this case, due regard shall be given to conducted interference and sensitive equipment connected to the same power distribution panel.

With respect to the EMC measures between the EM zones, e.g. at building walls, reference is made to (4.6) of this PTS. The results of the EM zone allocation plan shall be laid down in a report to be approved by the Principal.

NOTE: The results of the EM zone allocation can be laid down in one or more plot plans indicating the applicable EM zones and an equipment or system list.

2.4 Specification of EMC measures

During the engineering phase, the Contractor shall specify EMC measures in accordance with this PTS and implement these measures in the design. Where necessary, additional measures may be required as a result of the site survey, EMC matrix evaluation and EM zone allocation plan. The EMC measures shall be specified in a written report to be approved by the Principal.

A1.2.5 EMC risk assessment

The application of low emission and high immunity levels and (additional) EMC installation measures basically introduce higher costs for procurement , construction and commission ing. In many cases, the cost of EMC can be reduced by accepting some predetermined risk or by spreading the risk of EM interference . Where applicable, the Contractor shall carry out a risk assessment covering the following aspects:

- The necessity of requiring increased EMC performance, e.g. due to the large number of thunderstorm days per year. In this context, it could influence on the high voltage protective device degradation like a MOV varistor.
- The costs involved for adequate earthing, related to the soil properties and CP requirements, including maintenance aspects;
- The costs of exceptional EMC equipment specifications;
- Assessment of performance criteria according to IEC/EN immunity standards;
- EMI risk and alternative EMC solutions in case of non-compliant deliveries;
- The costs of exceptional EMC installation measures;
- Nalance between equipment measures and installation measures;
- Determination of the risks of failures in plant operation due to reduced compatibility (e.g. redundant control capabilities, communication links through different EM environments);

NOTE: Modern plant management systems rely more and more on (digital) telecom systems and, for remote areas, on radio links. EMC surveys in various plants located in tropical areas have revealed that lightning strikes in telecom towers are a major cause of interference because less attention has been paid to the earthing and bonding of antenna and obstruction light cabling than to earthing and bonding in process areas.

• possibility of taking corrective measures at a later stage (e.g., available space, earthing requirements, required plant shutdown).

The Contractor shall ensure a safe operational mode of the equipment and systems involved.
The results of any risk assessment , covering the acceptance criteria , the risk evaluation method and results as well as costs considerations. shall be laid down in a written report to be approved by the Principal.

A1.3 PROCUREMENT

The Contractor shall specify EMC requirements, covering area, immunity and performance criteria for all electrical and instrument equipment. The required EM levels shall be based on the EM zone allocation plan.
The Manufacturer/Suppliers' equipment specifications, including EMC installation instructions and testing and inspection results, shall be checked against the EMC requirements, the results of which are to be included in a FAT report which shall be approved by the Principal.

A1.4 CONSTRUCTION

The Contractor shall deliver proof of a correct implementation of EMC measures during the construction phase. For this purpose the Contractor shall prepare and fill out detailed checklists, covering the EMC measures per category such as earthing and bonding, cable entry inside buildings, layout of equipment rooms, cabinets , junction boxes and field instruments, cable trenches, cable trunking and cable segregation. Interfacing constructions with other installations require specific attention. Particular attention shall also be paid to inspection of bonding measures of concrete reinforcement just before concrete placement.

The Contractor shall deliver as-built drawings covering EMC-measures. including:

- earthing drawings showing the principle of earthing for the (instrument) installation;
- bonding details of civil works, including concrete reinforcement bars and steel structures;
- earth resistance readings of earth electrodes;
- cable trunking plans, including interconnections and interfacing with junction boxes and cabinets;
- typical bonding detail drawings, showing bonding connections of field equipment, metal conduits, piping etc.;
- cable routing plans showing the cable layout following the EMC cable class concept and typical layout of cable trenches.

The construction review involves visual inspection of the installation or (digital) photograph proof of EMC critical parts.

A1.5 COMMISSIONING

The Contractor shall deliver the documents as required for the engineering, procurement and construction phase.
On request of the Principal, an additional SAT may be part of the acceptance and commissioning procedure where EMC is critical. The Principal, or his representative, shall witness the SAT.

A1.6 MAINTENANCE

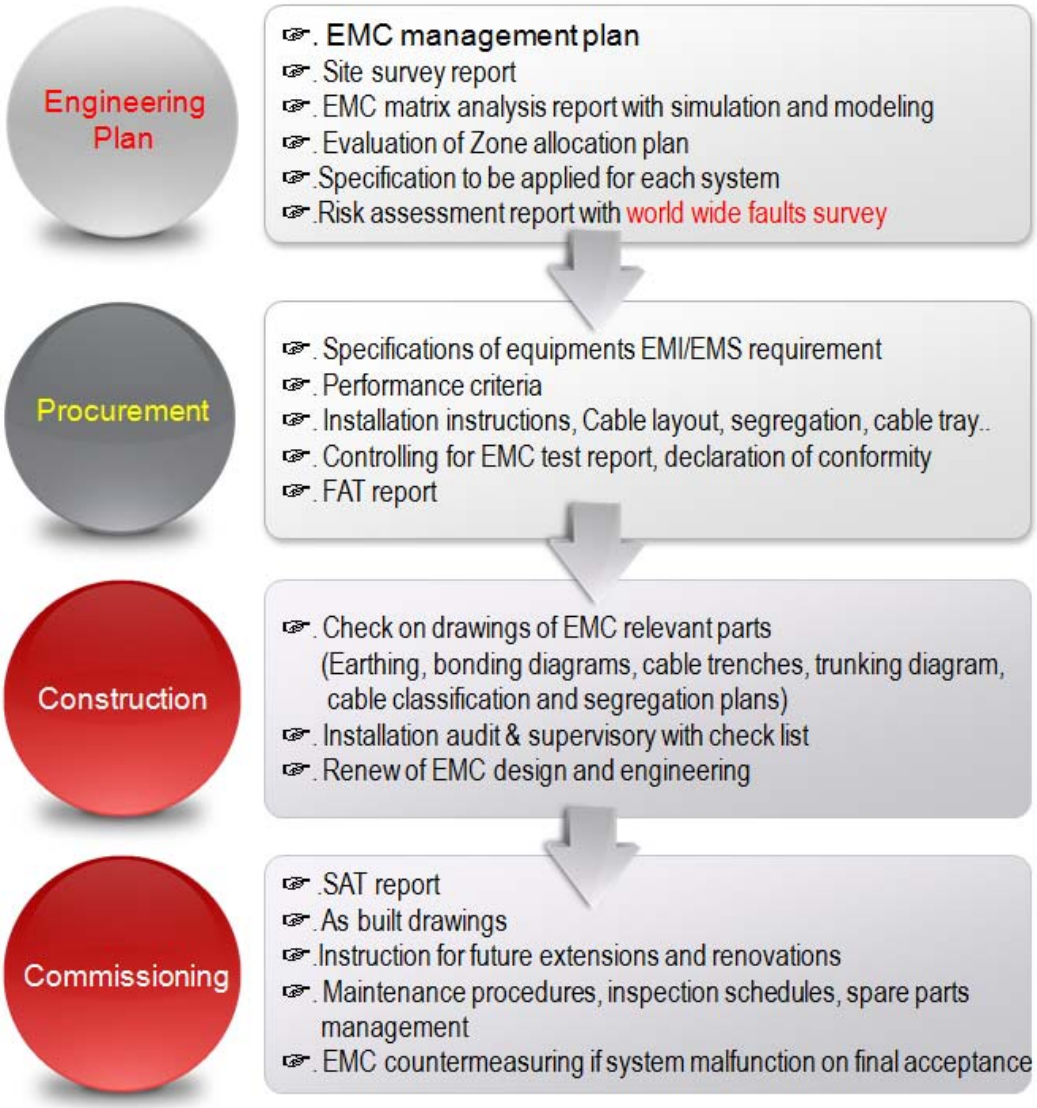
The Contractor shall present, where applicable , a maintenance plan covering maintenance aspects of equipment, installation parts and connections that are critical for maintaining the required level of EMC. The maintenance plan shall include maintenance procedures, instructions for periodic plant shutdowns, inspection schedules and spare parts management.

Typical maintenance work includes the regular inspection of earthing and bonding and continuity testing of cable supports, bonding straps and cable armour, and screen terminations . Furthermore , the following aspects should be addressed :

- cable entry point to segregated areas;
- integrity of equipment EM zoning;
- over-voltage protection devices and filters at the EM zone barriers;
- corrosion effects.
- MOV varistor degradation on each system and components for the elapse of years.

A1.7 DOCUMENTS AND STANDARD FORMS

The Contractor shall deliver the documents and reports upon following each step and EMC engineering procedure;



NOTES: 1. The risk assessment may be part of the EMC matrix evaluation report.

2. Because projects generally have to be completed within a limited time, construction phases do not follow clearly distinctive time frames. In the EMC management plan, due attention shall be given to information required for a specific phase. For example, detailed engineering may not be finished when the construction of (underground) facilities commences. In this case, a preliminary EMC checklist shall be prepared covering underground structures, in particular the earthing and bonding of concrete structures and foundations, earth grid layout, earth electrodes and cable trenches

EMC Engineering Procedure of KTI