Inefficiency of International Standards in the Production and Use of Electrical Equipment and Devices in Different Parts of the World

G.A. Shahryari: Hormozgan Regional Electric Company, Iran
M.R. Haghifam: Tarbiat Modarres University, Iran
A. Ahanchi: University of Maastricht, Netherland
C. Ford: Ardlin Ltd. Company, England


Summary:

The researchers have found out that the current standards of the electricity companies and the manufactures of electrical equipment, which are often in line with the ruling international and global standards, are basically incapable of meeting their technical needs. So a major overhaul should be made in the structure of such standards with regard to every region’s climatic conditions.

As the current standards are drawn up on the basis of a series of basic information for at least one-fourth of the world (the standards have envisioned at most four levels of environment and climatic conditions for the use of equipment), it is necessary to track down the hidden parameters which have been long ignored in the finalization of standards for the sultry areas.

The new standards should cover all aspects such as high temperature, intense humidity, severe pollution, high consumer demand of power and most important of all the prolonged hot and sultry season. The manufactures of electrical equipment should be informed of such consideration and attempt to comply with demands of their consumers.

The research is actually aimed at introducing proper models to the international standard organizations and manufactures of electrical equipment in the world. It will attempt to answer the following questions:

- Are the international standards and level such as IEC, JIS, BS, ASTM, capable of fulfilling needs of all regions and climatic of world?
- Is there any need for new standards?
- Are the current problems minimal and legible, or shall they be addressed to overhaul the standards?
- Should the standards be divided into smaller divisions and be categorized into sub-divisions?
- If the present standards are ineffective, then what are the reasons and cause of such ineffectiveness?

As a case situation and problems of Hormozgan networks are introduced.
Inefficiency of International Standards in the Production and Use of Electrical Equipment and Devices in Different Parts of the World

G.A. Shahryari: Hormozgan Regional Electric Company, Iran
M.R. Haghifam: Tarbut Modarres University, Iran
A. Ahanchi: University of Maastricht, Netherlands
C. Ford: Ardlin Ltd. Company, England

Abstract: In this paper inefficiency of electrical international standards for sultry regions is discussed. As a case situation and problems of Hormozgan networks are introduced. Then a proper model to the international standard organizations and manufacturers of electrical equipment for special regions is proposed.


1. Introduction: The researchers have found out that the current standards of the electricity companies and the manufacturers of electrical equipment that are often in line with the ruling international and global standards, are basically incapable of meeting their technical needs. So, a major overhaul should be made in the structure of such standards with regard to every region's climatic conditions. As the current standards are drawn up on the basis of a series of basic information for at least one-fourth of the world (the standards have envisioned at most four levels of environmental and climatic conditions for the use of equipment), it is necessary to track down the hidden parameters which have been long ignored in the finalization of standards for the sultry areas. The new standards should cover all aspects such as temperature, intense humidity, severe pollution, and customer high demand of power and—most important of all—the prolonged hot and sultry season. The manufacturers of electrical equipment should be informed of such considerations and attempt to comply with demands of their consumers. In these paper problems of Hormozgan Electric network in south of Iran as a case study is explained. This network was designed based on international standards. Then in this paper a proper model to the international standard organizations and manufacturers of electrical equipment for special regions is introduced. Therefore, it will attempt to answer the following questions:

- Are the international standards and levels such as IEC, JIS, BS, SSPB and etc.?
- Is there any need for new standards?
- Are the current problems minimal and negligible, or shall they be addressed to overhaul the standards?
- Should the standards be divided into smaller divisions and be categorized into subdivisions?

2. Geographical, Ecological and Environmental Situation of Hormozgan Province

Hormozgan’s climate is similar to other southern Iranian provinces such as Khuzestan, Boushehr and Sistan-Va-Baluchestan. It is actually Iran's border province along the Persian Gulf and Oman Sea. It is somewhat similar to the Saudi Arabia and southern India in terms of its sultry weather, high pollution and hot temperature.

The unfavorable climate, which looms over the province for seven months of the year, deeply scales down efficiency of the power equipment and installations. The unwanted hot weather often bogs down the network.

Hormozgan’s weather is excessively polluted, in part due to high temperature which climbs up to 53 degrees centigrade in shadow and 86 degrees centigrade in sunlight, the concentration of humidity and the 98 per cent rate of salt and calcium sulphate in the weather.

Meanwhile, a number of other factors deeply affect the provincial climate. They include: the seasonal winds precipitated by the air pressure between the Saudi Arabian Desert and southern India, the ever lingering regional dust, low annual rainfall (152.6 millimeters in 20 years) and the high rate of salt in the provincial lands. The industrial pollution of the province is predominantly cased by the spread of the lead and other suspended particles existing in the exhaust smoke of the numerous trawlers in the area.
3. Problems of network

Severe pollution affects all power equipment including isolators and copper and aluminum conductors. It also destroys the wooden, concrete and metal structures and pieces which even have a hot dip galvanized coating.

High temperature and humidity creates a sound atmosphere for chemical compounds. After a short period of time, the steel wires of aluminum coating-witch are used as electrical conductors in the network-are destroyed deep into the steel and have to be refurbished or replaced with new parts.

Likewise, the copper wires used in the low voltage networks and grounding, and the galvanized steel wires used as shield wire of high voltage networks become worn out.

Statistics indicate the explosion of power supply isolators, standoff insulators and the isolators of low- or high-voltage power substations; often causes prolonged power cuts although valid international standards such as IEC, JIS (Japanese), BS, ASTM and SSPB (Swedish) may have been applied in the network. The failures are to blame on the inefficiency of the existing facilities and the implementation of plans prescribed by the standards.

The power cuts are sparked as of 10 PM with the inflow of sultry weather, which combined with pollution, cover the surface of insulators and isolators,’ an issue that produces a creepage current on the outside and inside of insulators and continues until 9-10 AM.

With the initial disconnection of the power current, the insulators grow cold, causing compilation of further moisture on the surface and blocking reconnection of the power current.

Even the wooden substations, which are used to transfer electricity at a low or high voltage, particularly at 20 kilovolts, become scorched. The explosion of isolators and the burning of wooden substations are especially to blame on the sitting of dust and smoke on the surface of isolators and the leakage of moisture at night, an issue that practically turns the surface into an electrical conductor.

Meanwhile, the leakage distance flows from the surface towards the substations of insulators, burns their glazed surface, sets them off and scorches the wooden substation.

Isolators used in these areas are often a class higher than the standard level. For instance a 33 kilovolt isolator is used instead of recommend to use 21 isolators for every chain-50 percent more creep age distance – instead of the 13-14 insulator advocated by the IEC standard (11 kilovolts for every isolator dish. Meanwhile the voltage phase to the earth is calculated as 230 divided by square root of three).

Yet, the problem of the formation of electrical arcs at nights and the halo of sparks around the chain of isolators still remains in place, and the surrounding dishes of chains become powered.

The results of experiments performed an 33kv installation in the high voltage laboratory of khuzistane, and 33 kv installation, with due consideration to the related standards, are as Table-1.

<table>
<thead>
<tr>
<th>Voltage Interrupter Surface Insulator (kv)</th>
<th>Start of Voltage Current Passage (kv)</th>
<th>Type of Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>60</td>
<td>Dry state Without pollution</td>
</tr>
<tr>
<td>80</td>
<td>60</td>
<td>Wet state Without pollution</td>
</tr>
<tr>
<td>30</td>
<td>25</td>
<td>Wet state With little pollution</td>
</tr>
<tr>
<td>10</td>
<td>5</td>
<td>Wet state (spree) With heavy pollution</td>
</tr>
</tbody>
</table>

It is necessary to draw on the temperature of regions, as the most effective factor in the sustained supply of power to subscribers. In the sultry weather, life becomes intolerably difficult without cooling devices. The electrical energy actually plays the role of the weather, as a life essential, for the man in the tropical areas.

The gas air conditioners, which are widely used to produce cold air, consume a relatively high energy-a thumping three kilowatts that is far beyond other electrical home appliances. Thus, every residential unit needs at least two or three gas air conditioners, a figure which could raise its power demand, along with other home appliances such as refrigerator, illumination, audio and video devices to 9-12 kilowatts combined.

The sharp rise in power consumption has remarkably increased the difference between peak loads of summer and winter. Thus, the most amount of energy will be consumed in the hot season (summer) and fall by one-third in the cold season (winter).
Apart from the additional capacities which are installed to meet growing demands of the times of peak load in summer and the mammoth investments which they require, the draconian rise of consumption plagues the network in summer, pushing up temperature to its prime at most areas of the installations such as conductors and transformers. Along with the hot weather, the double heat inflicts heavy damage-around 16-20 per cent-on the network.

Combined with the losses stemming from the creep age currents of isolators (explained above), the damage will drastically diminish productivity of the power supply installations and reduce their efficiency by a whopping 50 per cent.

4 - The present situation of electricity installations in the regions under study

4.1 Indoor Installations:

Although the indoor installations such as 20 kilovolt grounding substations, protection boards, high voltage control substations and 20 kilovolt output cells are installed indoors, they face two main problems:

There is always some dust in the air, which sits on the horizontal and vertical surfaces. Despite frequent clearings of substations, electrodes. As the dielectric number of the particles is larger than one, even if the particles have no electric charge, they will still be attracted into the areas boasting electrical field and gather around the electrodes.

As soon as there is an incomplete discharge, the particles become charged, creating an electrical field and attracting other particles suspended in the air. Thus, increasingly more particles are attracted towards the electrodes of isolators.

The thin layer of environmental pollution on the outer surface of isolators will reduce their electric resistance. Meanwhile a leakage distance, matching with the electrical conducting capacity of the pollutant particles, will cross the side surface of insulator, sparking an electrical arc. Moisture will intensify the situation.

Another major problem besetting indoor installations is the surface waters and the high level of water in the coastal areas, an issue that has long been ignored in the designing and developed of electrical equipment.

The power substations contain canals, which are designed to cover the electrical cells and boards and the wiring. Due to the high level of underground waters in the coastal areas, water usually dumps and vaporizes in the canals. Along with the moisture suspended in the air, the steam turns into raindrops and sits on the conductors and isolators, triggering short-lived powerful sparks. The water penetrates into the inside canals and corrodes the cables used for dry lands.

The substations, which even do not have the problem of water dumping, have frequently happened to spark or explode, in part due to the moisture amassed in the closed spaces and the ionization of water between the phase and the body of boards. The matter blocks the current's circuit

4.2 Conductors, Connectors, Clamps, Jumpers and Ground Wires:

Conductors, connectors, Clamps, Jumpers and Ground Wires are at risks from two main aspects

Pollution and Corrosion: Oxidization destroys and removes the mechanical resistance of metal equipment, be it aluminum wires. Copper wires, alloy wires or steel wires

Documented evidence indicates corrosion destroyed a 591.2 square diameter wire (curlew) so that its inner steel was even destroyed and tore apart the wires.

Due to the penetration of pollution into the wires and the heterogeneity of metallic pieces such as screws, bolts, clamps, connectors etc, the two deterrent metals placed in an electrolytic solution would form an electrical cell and exchange an electrode current. The current flowing from anode to cathode will lead to galvanic corrosion. Metals such as copper and its alloys have a higher potential of electrode in comparison with aluminum. Therefore, the proximity of such pieces will speed up corrosion process.

The ground wires, which are often made of steel or copper, are potentially at risk of corrosion. The corrosion takes place right at the connection point of the wires to the earth, leading to failure of protective equipment. The failure inflicts substantial-and irreparable-losses on the electrical installations.

4.3 Concrete, Wooden and Metal Substations:

Chlorine ions penetrating into the concrete substations from the small cracks corrode the metal reinforcements of the substation, causing the shield layers to swell. The corrosion reduces the substation's productive age by one-third. Consequently, the concrete lining of the metal reinforcements break apart.

The corroded iron beams burst out of the substations and the structure loses its mechanical strength. Unless
the substations are rapidly changed, the network will break down.

In the metal substations, which are often used in the illumination networks the high pollution arriving at the standoff insulators of the low-voltage networks produces a leakage distance, which is transferred to the body of the substation. The electric current existing across the body of the substations often shocks the passers-by or the animals prowling around.

In the wooden substations (as was mentioned earlier), the peak of the beam often burns, leading to the segregation of the standoff insulators mounted atop, or the console. The disconnection of wires rightly follows the event.

4.4 Transformers:

Transformers are at risks from two aspects. Each year, around 100-120 sets of transformers (two per cent of the air distribution transformers) sustain damage and get out of stream.

The first reason is the corrosion of the body-of transformers, and the oil tank, an issue that will lead to the leakage of oil and flaw in the insulation of the transformer.

The second cause is the penetration of humidity into the transformer tanks through ventilators or the holes created via corrosion in the former case. Thus, drippings of water or sludge are dumped inside the transformer, reducing its insulation and raising dielectric losses. The eventual result is the electrical failure of transformers and their burning.

Two photos about corrosion in Horozgan are shown in end of paper.

5. Necessity of the new standards:

A view of the above mentioned notes will reveal that all parts of the power installations—whether made of ceramic, metal, wood, concrete—are directly exposed to such conditions.

Early ageing of networks, waste of national or global coffers, unreliability of networks, failure in making maximal use of electrical energy, consecutive power blackouts, consumer dissatisfaction and mammoth investment for the cleaning of isolators are just to name a few of the common problems in such Ares.

In the Hormozgan Electricity for instance, 15,000 cubic meters of distilled water were needed to wash the isolators. The cost of purchasing of 1 cubic meter distilled water is 100 thousand rails (11 dollars). It means, apart from the labor and machinery expenses, each year 165 thousand dollars should be siphoned off to purchase distilled water.

Meanwhile, the annual expenses of repairing and refurbishing amount to a staggering 3 billion rails.

The expenses stem from the specific climatic condition of the to the region, which has posed itself as an actuate technical and social plight to the people, and thrown up serious obstacles on the exploitation of power networks.

The problem stems from the fact that the current international standard by the manufactures of electrical equipment and the executive organizations, only have three or four levels of quality for entire world. So, they are incapable of fulfilling needs of the various climates, which have remained unknown to international researchers and experts.

The engineers and experts working with the electrical instruments have closely perceived the fact that the so-called standard equipment, put at their disposal, fail to carry out the same tasks in climates with the same basic information.

5. Priorities in planning of efficient standards.

5.1 Economic Priority:

A: As was mentioned earlier in the research, there are numerous intolerable glitches in the networks, particularly with experts and technicians of every region often put forth solutions, some of which are in deed exorbitant and fail to produce the favorable results. For instance, no commendatory result has been achieved from the rise from 14 to 20 or 21 in the number of the chain of isolators) which is itself promoted by the increase in the creep age distance in the 230 kilovolt lines. Besides, it has triggered other problems such as plunge in clearance and the emergence of extra mechanical force in excess of the line's standard. There are many other similar cases, for which the local experts have sincerely attempted to put forth solutions or remove the problems, but they have soon found out their suggestions. Such measures deal double costs on the company in question and distance the experts from their main duty.

B: The regional companies involved in such problems bear further costs in excess of their routine expenses such as washing of lines, permanent painting of metal pieces and installation structures, refurbishment of the concrete parts of foundations, daily cleaning of substations and indoor and outdoor equipment.
For instance, in Hormozgan Regional Electricity Company, the budget allocated to the improvement and stretching of distribution and transfer networks stood at 13 billion rials, while the maintenance costs hovered around 10 billion rials.

Thus, one of the main agendas of new standards should be prevent waste of time and expenses.

### 5.2 Scientific-Technical Priority:

Detection of the destructive factors and the proposal of viable scientific and practical solutions cited above will certainly open a new scientific chapter in this field. It will actually serve as an appropriate pattern in the manufacture, development and application of electrical equipment for the regions in question.

The new standards should be fruitful both to the manufacturers and users of electrical equipment, and to the universities and other educational institutes of the world. Thus, new scientific topics may be taught at the universities. It may even open up a new scientific field on the manufacture and use of electrical equipment in other regions of the world (the regions whose problems are different from the above mentioned region).

### 5.3 Cultural-Social Priority:

Consecutive power cuts and glitches in the distribution of electrical energy, especially in the sultry climates entails a variety of mishaps including subscriber indignation, educational television or radio program, pause in the operation of public places.

The cases have prompted the citizens to file numerous complaints with the provincial and other state officials to settle the problems.

### 6. Conclusion

In this paper inefficiency of current international standards in special region is discussed. As a case a sultry regions in Iran was selected. It seems that in addition to the general standards currently being widely used at international scale, it is necessary to identify other joint variants which can produce profound impacts, with the standards of each and every region in light of regional standards division so that their details and special features are heeded and that plans are worked out to meet their needs.

### 7. References:


2. International standards documents (IEC, ASTM, IEEE, ASTM, SSPB)

Photos about corrosion of metal structures in substations and cables: