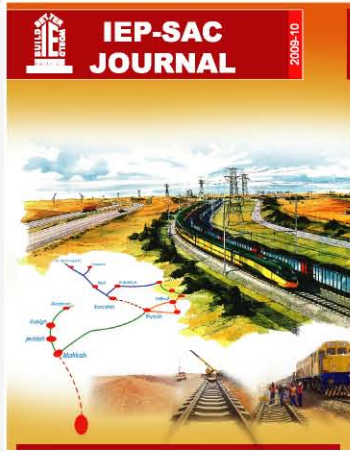




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In This Issue

2009-10

CONTENTS

- 4 From the IEP-SAC Chairman
- 7 Message From the Ambassador
- 8 Obituary Obaidullah Siddiqui
- 10 Annual Report From the General Secretary
- 14 IEP-SAC Council Members
- 18 IEP-SAC Standing Committees
- 20 Scenes From the Central Region
- 25 Report From the Eastern Region
- 26 Council Members Eastern Region
- 29 Standing Committees Eastern Region
- 30 Scenes From the Eastern Region
- 36 Report From the Western Region
- 37 Council Members Western Region
- 40 Scenes From the Western Region

ARTICLES:

- 44 Recent Trends in Integrated Water and Power Production
- 52 Green Bldg
- 58 Understanding EVMS
- 64 Transformer Tap Changer
- 70 Duplex Steel
- 75 IEP-SAC Directory
- 123 Registration Form
- 124 IEP BAHRAIN Center
- 125 Our Patrons

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IEP-SAC Journal is published yearly by the Institution of Engineers Pakistan, Saudi Arabian Center (IEP-SAC), Riyadh, and distributed to the engineering community in Saudi Arabia. To promote discussion of issues in the field of engineering and ensure coverage of all responsible points of view, conflicting opinions and views may appear, however, IEP-SAC cannot accept any liability for such views nor for any errors or omissions.

From the Chairman

It is my great pleasure to present the current (2009– 2010) IEP-SAC Journal and directory of Pakistani engineers living in the Kingdom. This journal and the directory is compiled and printed through the collective and tireless efforts of the IEP-SAC council members under the auspices of the newly formed Editorial Board. As you will notice, the new editorial board has given this Journal a very pleasant uplift. The change can be felt by the reader starting with a fresh cover design to the revised layout and professional designing to the state of the art printing—this all tells the story.

IEP-SAC is a live and vibrant albeit a non-profit organization. The main objectives of IEP-SAC are to provide a forum for Pakistani Engineers living in the Kingdom to update their professional knowledge, facilitate communication and comradeship and help the new generation of the Pakistani engineers through an ambitious scholarship program. General Secretary's report in this Journal will highlight IEP-SAC's activities achieving these objectives. You may also visit our website at www.iep-sa.org.

Another great news is that we've successfully set up a new sub center in the Western province based in Jeddah along the same lines as the Eastern province center was earlier set up in Dammam.

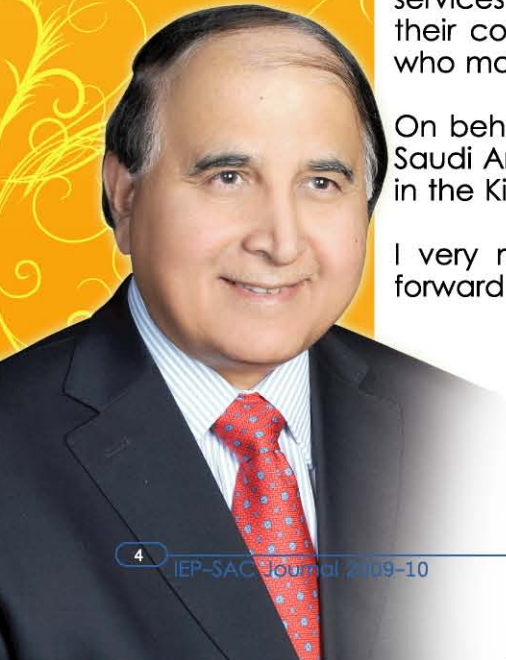
I call upon the Pakistani engineers living in the Kingdom to come forward and participate in the IEP-SAC activities. This is the voice of your community and this forum is for you. Attending IEP seminars and other activities not only would support professional advancement, it also provides opportunities for get together and wider networking not so easily available otherwise.

We wish to express our deep appreciation for the very valuable voluntary services of our IEP Council members. We are also thankful to IEP Pakistan for their continuous support. We are grateful to the sponsors and advertisers who make the publication of this Journal possible.

On behalf of IEP-SAC, we wish to express our gratitude to the Kingdom of Saudi Arabia for its hospitality and cooperation to the Pakistani community in the Kingdom in general and Pakistani engineers in particular.

I very much hope that this Journal will meet your expectations. I look forward to meet you in the upcoming events of IEP-SAC.

Engr Masood A Khan
Chairman



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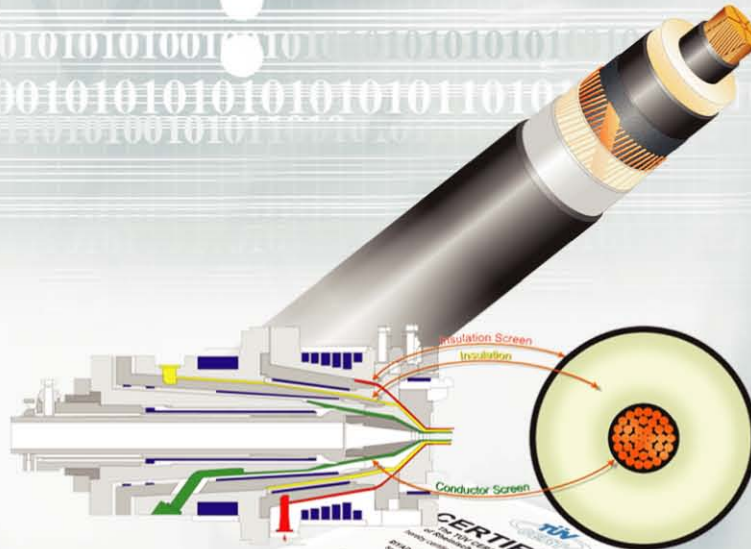
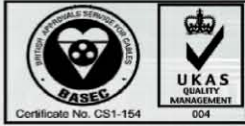
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FROM THE AMBASSADOR

I am at the height of ecstasy to pen down this message on the publication of IEP-SAC Journal for the year 2009-2010. Indeed, this Journal would be of paramount significance and would go a long way in providing immensely useful information for those engineers rendering invaluable services in augmenting the brotherly and cordial relations which so sweetly exist between Pakistan and Saudi Arabia.

The updated articles published in the Journal depict various aspects of their technical and professional expertise. It also carries valuable information vis-à-vis activities of the Institution of Engineers Pakistan, Saudi Arabian Center (IEP-SAC).

On this august occasion, I feel head and shoulders above the engineers of different nationalities working in the Kingdom in order to add unfathomable grandeur to Pakistan by dint of their untiring efforts, un-fencing resolve, devotion, dedication and perseverance. This forum would certainly play a very important role in the uplift of infrastructure of our brotherly country Saudi Arabia.

I avail of this opportunity to elaborate that our sagacious engineers of this forum have made positive headway in pursuit of their enormous goals and have successfully upheld this very cause.

You are fully cognizant of the fact that currently Pakistan is passing through a hard time of its history and it is the duty of all and sundry to magnify the image of our homeland in the Kingdom.

Above all, your organization has played a pivotal role in reinvigorating the spirit of brotherhood among Pakistani engineers and their families and also among engineers of different nationalities working in the Kingdom. Your continued financial support to the engineering students of Pakistan's public sector universities is another noble cause for which I can rightly say, "hats off to you".

Lastly, I avail of this opportunity to felicitate IEP-SAC and all other engineers on organizing the 2009 annual technical seminar on a very important topic on takeoff and landing requirements for a commercial turbojet aircraft.

Muhammad Sarfaraz A Khanzada
Acting Ambassador
Islamic Republic of Pakistan
13 May 2009

إِنَّا لِلّٰهِ وَإِنَّا إِلَيْهِ رَاجِعُونَ

Obituary

Engr OBAID ULLAH SIDDIQUI
(1940 - 2009)



Engr. Obaid Ullah Siddiqui – popularly known amongst his colleagues at the Institution of Engineers Saudi Arabian Center (IEP-SAC) simply as Obaid Bhai – passed away peacefully in Karachi on 23rd February 2009.

A graduate of Civil Engineering from NED Engineering College-Karachi in 1965, Obaid Bhai was a fine professional engineer and a person of great qualities. He was loved, respected and

admired by all and that is the reason he is missed so very much on every occasion.

Obaid Bhai was considered as one of the founder members of IEP-SAC and his contributions for the same remain plenty and unforgettable. He served diligently putting his best in every assignment that he was entrusted with. Special mentions are his services for the Social, Sports, Scholarship and Technical Committees of IEP-SAC.

He always found time for the Pakistani community in Riyadh for whom some of his services remain most commendable. For instances, he played a constructive role to better the affairs of the Pakistan International School at Nasiriyah.

He was a true patriot and had an immense love for his country – the signs and symptoms of which were demonstrated through his actions and words on the daily basis.

Obaid Bhai lived and worked in the Kingdom of Saudi Arabia since past more than 30 years or so. His professional contributions for the development of Saudi Arabia are many and he often mentioned with immense pride about his prominent role and technical contributions towards expansion of Masjid Haram in Makkah.

He is survived with a wife and four children; two sons and two daughters. All of them are married and well placed except the youngest son who is a fresh graduate of engineering.

The entire team of IEP-SAC, of all chapters in the Kingdom, remain profoundly grieved at his sad demise. They all also remain in prayers for his maghferat, amen!

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ANNUAL REPORT

From The General Secretary

By the grace of Almighty Allah, IEP-SAC has successfully completed one more year of its dedicated services. It is my honour and pleasure to present the annual report of IEP-SAC on the activities and events that took place during the year 2008-2009 and to take you in confidence on the objectives that I believe will set a positive course for the future. I have taken over the responsibility of General Secretaryship from Engr Dr Nazar Malik, who has stepped down from his responsibility due to his personal reasons. Nevertheless, I have enjoyed full support and guidance from Dr. Nazar Malik for which I am thankful to him.

Gentlemen, At this stage I would like to recall the message of Quaid-e-Azam Mohammed Ali Jinnah on the occasion of inauguration of IEP, on 20th June 1948, he had proclaimed: "If Pakistan is to take its proper place among the progressive nations of the world, it will have to take up a good deal of leeway in the realm of scientific and technical education which is so necessary for the proper development of the country and utilization of its resources." unquote

By the grace of Almighty Allah IEP-SAC has been actively pursuing its objectives and is trying with full enthusiasm to accomplish the task identified by Quaid-e-Azam Mohammad Ali Jinnah. In this regard IEP-SAC arranges technical seminars, publishes its annual journal with technical papers and the directory of Pakistani Engineers residing in the KSA. Besides, national and international participation of our members, mutual collaboration with sister organization in other countries has benefited the engineers themselves by sharing of the latest technical knowledge but also bring lasting benefits to the public service. IEP-SAC also runs an ambitious scholarship program.

To keep the worthy members informed, a brief of the technical and social activities made during the year 2008-2009 is as following:

SEMINARS

IEP-SAC organized its annual seminar and dinner on June 05, 2008. Two technical presentations were made:

i) "Quality Management System" presented by Mr. Mobin Sheikh, Director and Principal Consultant, Infovision Consultants W.L.L.

ii) "Smart Industrial Cities". Presented by Dr. Tauwfiq Rabia, Director General SOIETZ. Both presentations were well received and enhanced the audience's awareness. On this occasion customary IEP-SAC Journal featuring technical papers and a Directory of Pakistani Engineers working in the Kingdom of Saudi Arabia was published. Our annual seminar always includes a technical exhibition of Saudi engineering companies to introduce and display their products and services.

iii) A second technical seminar was held on January 08, 2009. Its topic was "Recent Trends in Integrated Power and Water Production". The presentation was given by Engr. Paddy Padmanathan, President and CEO of ACWA Power international. The presentation was very interesting and thought-provoking; and resulted in a lively session of question and answers. The venue was Hotel Marriot where a sumptuous dinner was also served, thanks to ACWA for hosting the event.

ANNUAL REPORT

From The General Secretary

FAMILY PICNIC

The famous social event of IEP-SAC is the family picnic, which was organized on February 21, 2009. It was attended by more than 400 family members and was a full day busy event. Such events are very much appreciated and provide opportunities for cementing ties among engineering community in a relaxing and entertaining environment.

SCHOLARSHIPS

It is a matter of great satisfaction and thanks to Almighty Allah that our scholarship program which was started 13 years ago in 1996 is progressing and attaining respectable appreciation. Our scholarship program is primarily funded through donations and sponsorships. These scholarships are offered to high-potential but needy engineering students studying in public Engineering universities and colleges in all four provinces of Pakistan and state of Azad Jammu and Kashmir during the entire scholarship year. This year we have offered 88 full scholarships. I will avail this opportunity to appeal to Pakistani Engineers and community in general to come forward and participate in this noble cause.

OBJECTIVES

If IEP-SAC is to continue to be one of the best technical societies, then we must constantly monitor the ground realities and wisely change the course of action to meet future challenges. The following are our tactical objectives that I believe will set a positive course for the future.

- i) Increase IEP-SAC membership.
- ii) Improve and enhance IEP-SAC website and keep it active on a continuing basis.
- iii) Expand IEP-SAC scholarship program.
- iv) Build and improve coordination between IEP-SAC and other technical societies.
- v) Encourage Engineers for writing technical papers.
- vi) Develop an effective coordination with IEP-SAC local councils in Eastern and Western provinces.
- vii) Support engineering universities of Pakistan in carrying out projects and theses by sharing our latest technical knowledge and experience.

APPRECIATION

IEP-SAC expresses its gratitude to the Government of Custodian of the Two Holy Mosques, King Abdullah Bin Abdul Aziz Al-Saud for facilitating our stay in the Kingdom. I am thankful to our council members for their tireless efforts in making our activities real success. I also appreciate the support and guidance of IEP Headquarters and the full support we enjoy from the Pakistan Embassy in Riyadh. I am grateful for the support of all Pakistani engineers living in the Kingdom and my personal appreciation for our chairman IEP-SAC Engr Masood A Khan and outgoing General Secretary Engr Dr Nazar Malik for their continued support and encouragement. Finally, I wish to extend my deep appreciation to all brother engineers, sponsors, advertisers, press and media personnels and all other guests and well-wishers for their cooperation and support of IEP-SAC activities. I also wish to extend our appreciation to local council in Eastern province for its efforts and cooperation in raising cooperation the funds for our scholarship program.

Before I conclude, I would like to announce with deep sorrow and grief the sad demise of, our senior colleague and one of the founder member of IEP-SAC, Engr. Obeid Ullah Siddiqui on 23rd Feb. 2009. We pray for the departed soul and offer deep condolences to his family and to all other concerned.

Engr S M H Kirmani
General Secretary



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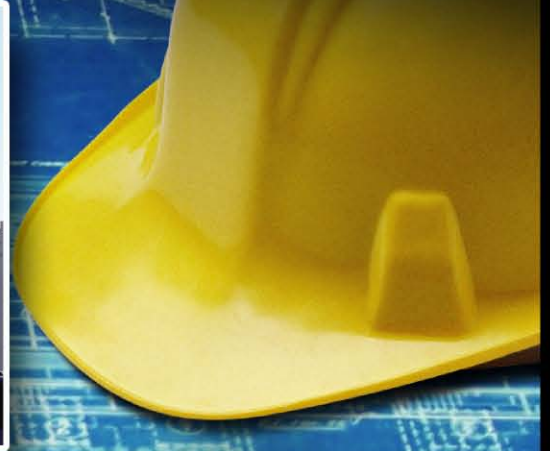
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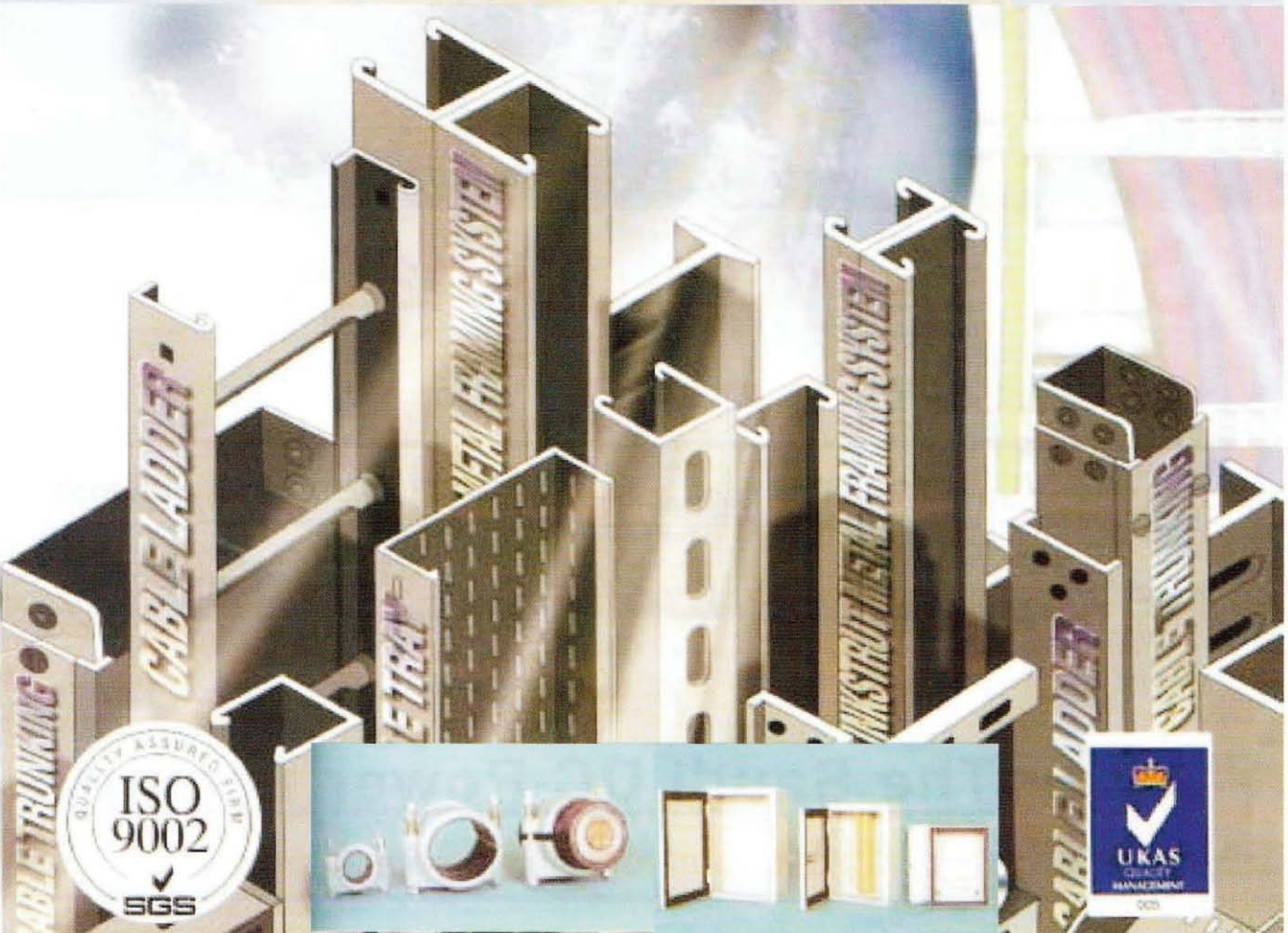
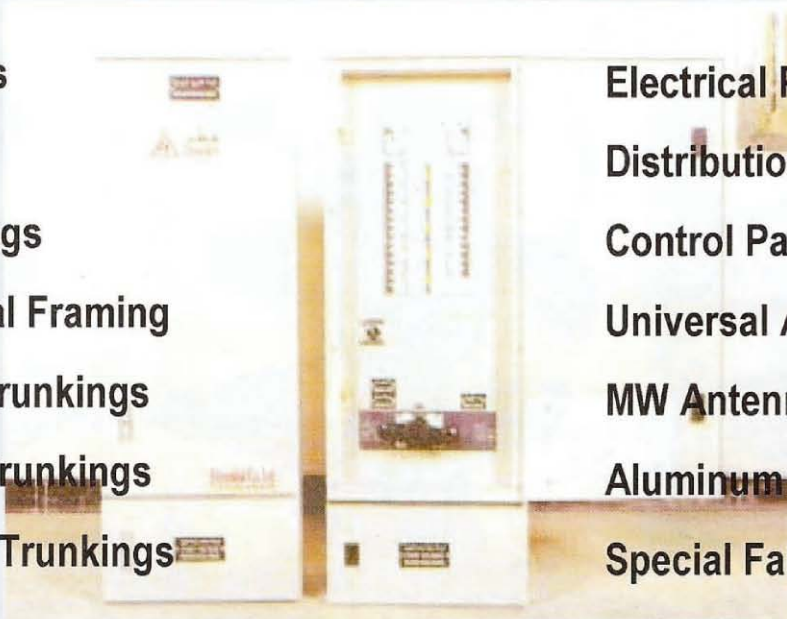
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CENTRAL REGION

IEP-SAC Annual Seminar, June 5, 2009, Prine Salman Cultural Center, Riyadh:

- i) "Quality Management System" presented by Mr. Mobin Sheikh, Director and Principal Consultant, Infovision Consultants W.L.L.
- ii) "Smart Industrial Cities". Presented by Dr. Tauwfiq Rabia, Director General SOIETZ.



S

CENES FROM IEP-SAC Activities

CENTRAL REGION

IEP-SAC Technical Seminar, January 08, 2009, Hotel Marriott, Riyadh: "Recent Trends in Integrated Power and Water Production" Engr. Paddy Padmanathan, President and CEO of ACWA Power international.



S CENES FROM IEP-SAC Activities

CENTRAL REGION



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CENES FROM IEP-SAC

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Report From the Eastern Region

On behalf of IEP-SAC Eastern Region, I am delighted to report activities and events that IEP-SAC-EP has organized during 2008/2009. We have focused on our main adjectives of sharing latest technical knowledge among engineers, running an ambitious scholarship program for deserving engineering students in Pakistan and bring engineers from all disciplines closer and together on IEP-SAC-EP platform.

IEP-SAC-EP organized Technical Seminar on Monday Nov 26th, 2007 on "Innovative Industrial Flooring System" Presented by Engr. Aymen Mamoon of Sika Gulf. Chief Guest was Mr. Adnan A. Al-Nueim, Secretary General Chamber of Commerce & Industry (Known as Sharqia Chamber) Dammam.

Another Technical Seminar was organized on 7th May, 2008. The topic was "Prosperity Through Education and Research" presented by Engr Dr Asrar-ul-Haq Sheikh, Chair Professor in Telecommunication at King Fahd University of Petroleum and Minerals (KFUPM). His Excellency Admiral (R) Shahid Karimullah, Ambassador of the Islamic Republic of Pakistan to Kingdom of Saudi Arabia graced this event as Chief Guest. Engr M Tariq Barlas, CEO and Vice Chairman of Al-Tuwairqi Group of Companies was the Guest of Honor and the key-note speaker who spoke about his hands-on experience spanning over 28 years in KSA. The Seminar was very well received/attended by the Eastern Region engineering community and appreciated by H.E. the Ambassador.

IEP-SAC-EP organized another Seminar in 18th March, 2009 on "Innovative Techniques in Pilling and Geo Engineering" presented by Engr Pervez Naushahi, General Manager of Ground Engineering. Engr Abdullah Sadaat, President Scado of Al-Khobar was the Chief Guest. Seminar proved to be very successful and attended by a vast number of multi-national engineers from all over Eastern Province.

IEP-SAC-EP delegation paid special visit to Sharqia Chamber and offered Pakistani engineers' support for the Chamber. They were very well received and their efforts/activities were appreciated. This event was covered in the March 2008 Issue of the Saudi Commerce & Economic Review.

IEP-SAC-EP celebrated Eid Milan, a family get-together program which also included a farewell dinner to our General Secretary Engr Javed Iqbal who transferred to Qatar.

IEP-SAC-EP has the honor to announce eleven scholarships exclusively from Eastern Province for engineering students in Pakistan. This is in addition to the regular contribution from Riyadh Center since the last decade. IEP-SAC-EP wishes to express its gratitude to the Kingdom of Saudi Arabia for its continued hospitality and support to the Pakistani engineering community and our valued sponsors to achieve our objectives. All these activities are organized by absolute volunteer work by all IEP Council Members with dedication, commitment, and continued enthusiasm.



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Chairman IEP-SAC-EP

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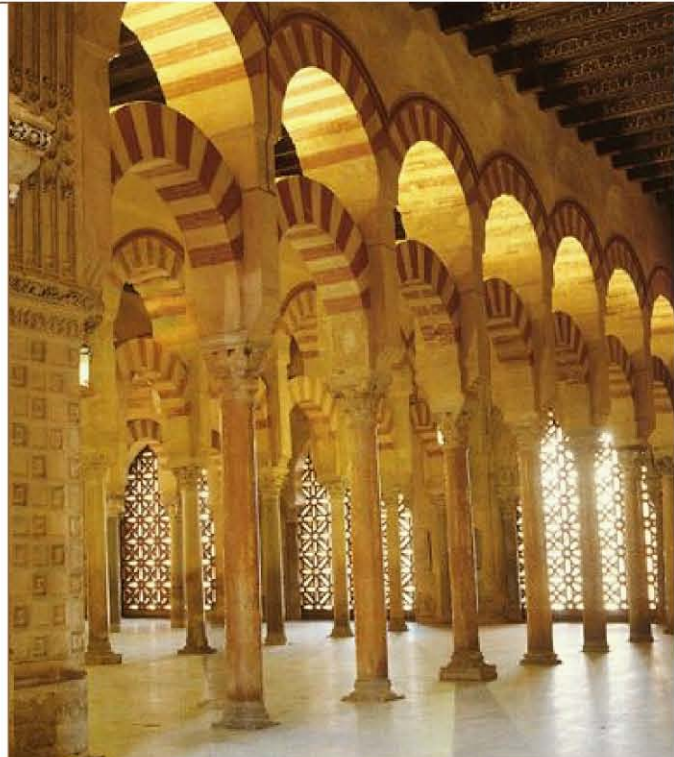
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The Great Mosque of Cordova

Córdoba (Arabic: قرطبة [Qurtuba], in English: Cordova) is a city in Andalucía, southern Spain, and the capital of the province of Córdoba. Located at 37.88° North, 4.77° West, on the Guadalquivir river, it was founded in ancient Roman times as Corduba by Claudius Marcellus. Its population is about 400, 000.

In the 10th century, Córdoba was one of the largest cities in the world, as well as a great cultural, political and economic centre. The Mosque of Córdoba dates back to this time. In the present, Córdoba is a major cultural focal point in Southern Europe, considered as one of the most beautifully preserved cities, and a city with great quality of life in Spain.



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CENES FROM IEP-SAC Activities

EASTERN REGION



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EASTERN REGION



167 MARCH
ISSUE 2008

SAUDI COMMERCE & ECONOMIC REVIEW

Pakistani Engineers Seek Closer Ties with Chamber

Pakistani engineers with Chamber officials.

A DELEGATION of Pakistan engineers called on the Secretary General of the Asharqia Chamber Mr. Adnan A. Al Nueim on March 2, to discuss cooperation between the Chamber and the Institution of Engineers Pakistan (IEP).

While welcoming the Pak engineers, Mr. Al Nueim acknowledged the contributions of Pakistani community to Saudi Arabia. He also presented Chamber of Commerce Shield to Engr. Rizwan Ahmad, IEP Chairman, who headed the delegation.

The IEP is dedicated to helping in acquisition and exchange of technical knowledge among engineers and extending it to public as well. It is also engaged in disseminating among its members information and updates in the field of engineering. IEP also plays a role in expanding knowledge and information by holding seminars/conferences and publication of technical

papers. It maintains a database of Pakistani engineers working in Saudi Arabia.

Also present at the meeting were Mr. Abdulwahab M. Al Ansari, Assistant Secretary General, Media & Public Relations, Mr. Abdullah M. Al Qahtani, Assistant Secretary General, Economic Affairs and Mr. Saeed Abdullah Al Zahrani, Manager

Adnan A. Al Nueim, Secretary General, Asharqia Chamber, presents a memento to Engr. Rizwan Ahmad

International Relations of Asharqia Chamber.

IEP delegation had besides Engr. Rizwan Ahmad, Engr. Khawaja Ismet Amin, Ex-Chairman; Engr. Jawaid Akhtar Niazi, Vice-Chairman; Engr. Zaheer Shah, Secretary General; Engr. P. Naushahi, Finance Secretary; Engr. Aziz Arshad, Ex-Secretary General; and Engr. Abdul Kadir Akbani.





AL-TUWAIHQI HOLDING

CHAIRMAN'S MESSAGE

The population of the world continues to grow and the increasing demands for the raw materials, particularly metals and minerals is becoming ever more interlinked putting pressure on global resources which are becoming a constraint to economic growth. Technology continues to play an important role in every aspect of developments while globalization comprehends the movement not only of physical goods, but also services, finance, people, information and ideas. Technology is also allowing exchanges of the developed and developing worlds to merge and provide sophisticated trading products.



With info-tech dominance as the backbone of our common outlook, the remarkable growth and success of Al-Tuwairqi Holding Co. (ATH) can be attributed as a result of gradual process of reinventing, utilizing financial strength and skills derived from its human resources. Strong foundation mixed-up with well-defined objectives, commitments & decisiveness, we can prove that even the best can be improved to warrant certain criteria.

The strategic future market challenges of ATH calls for constant brain storming, broaden up its vision and crystallize innovative ideas. Commitments plus quality, dedicated efforts of all ATH teams and putting priorities to customer's satisfaction had made to register tremendous achievements in the Kingdom of Saudi Arabia on steel sector during the last decade. ATH success has resulted to secure its place on the way to the peak and steadily uphold leading position in its steel business journey.

These are evidently our potential tools of mammoth future success. With highly skilled human resource and latest technology, we can build the future of our dreams.

Dr. Hilal H. Al-Tuwairqi
Chairman – Al-Tuwairqi Holding Co.



MISSION STATEMENT Our mission is to provide efficient services and quality products by selecting continuous development programs, with a good team spirit, the use of advanced state-of-the-art technology, whilst maintaining high level safety strategies and remaining friendly to the environment. Customer satisfaction will be achieved by putting them as our top priority and displaying the best quality of mutual respect.

VISION To become a socially responsible, efficient and professionally managed Global Steel Player by capitalizing on the competitive advantages and natural resources of the GCC and Middle East region and to become an employer of choice for qualified and competent human resources.



AL ITTEFAQ STEEL PRODUCTS CO.



Al Ittefaq Steel Products Co. (ISPC-1) is one of Al-Tuwairqi Holding and is considered as a premier & one of the biggest of its kind in the Kingdom & the Middle East in the private sector producing hot-rolled, high tensile, weldable reinforcement steel bars of sizes from 12mm to 40mm, manufactured by using the Thermex Bar Quenching process, 8mm and 10mm rebars and 5.5mm to 14mm plain round coils through wire-rod Mill. ISPC products are confirmed to National and International Standards.

ISPC-1 is achieving a production of 1.65 million tons per annum and has secured its leadership position through innovative management strategy. Located at Dammam, Eastern Region, Kingdom of Saudi Arabia, ISPC-1 humbly rises with its goals, employs around 600 people and operates round the clock. New Rolling Mill, ISPC-1 had reached again its mastery on this stage of development where it has successfully commissioned its new rolling mill on August 2, 2007. Apart from its two existing rolling mills (R1 & R2), R3 rolling mill adopts a non-stop rolling using an Electric Arc Fusion Welding. The mill is operated via cascading motors from finishing stand down to the roughing mill, four-slit-rolling for smaller size is also implanted on the design of the mill with 18 mill stands. R1 and R3 mills are capable of producing 8, 10 and 12mm four slit 14, 16, 18 and 20mm two slit 25, 28, 32, 36, 40 and 50mm single rolling.

To effectively address the increasing demands, Al-Tuwairqi Holding Co. responded positively by creating and upgrading steel mills. Situated within 262,000 m² of private land, 4 kilometers west outside the Holy Place of Makkah, **Al-Ittefaq Steel Products Co. (ISPC-2 Makkah)**, a new division of Al-Tuwairqi Holding came into its existence. On each investment projects everything has been carefully studied and planned to achieve the target in the most profitable manner. By utilizing the existing machineries, adding new machineries and utilizing its owned sources of manpower, associated with tedious works to upgrade an old mill, the company has enabled to increase new capacity of 400,000 tons projected annual production on its first stage. ISPC-2 Makkah's production of its reinforcement steel bars will cover the market requirements in the nearby region being supplied and supported by our Al-Ittefaq Steel Products Company in Dammam, Eastern Region.

The second rolling mill (Makkah Mill) is commissioned in 2008 to produce 1.35 million tons/year of reinforced steel bars, round bars, flats, special & high quality steels. In the covered area of 42,000, the plant consists of 2 Reheating Furnaces, Endless Welding Rolling Machine, 20 H/V stands, 120 meter long Cooling Bed and 2 bundling stations to handle finished bars up-to 18M long. Total weight of the installed equipment is more than 10,000 tons.

We value our employees' enhancement in the new technology through good training and seminars. Proper trainings resulted to skillful awareness and understanding of all technical know-how. "Safety First Policy", by ensuring employees is equipped with sufficient knowledge & ability to safely perform their works. We advice, that each individual must take charge of his safety. We trust that no amount of production is worth any amount of risk to the well being. We confide that we can reach our production goals thru safe work practices and safety training. We regard that the safe way is the greatest way to do any job. We believe that injury can be avoided if we observe reasonable caution and use good judgment in performing our jobs. We feel that individual should develop a "sixth sense" of safety awareness.



NATIONAL STEEL CO. (NASCO)



The melt shop project was entirely managed by the Al Tuwairqi Holding Co. NASCO started its production on 16th June '04 and with lot of developmental activities. NASCO has produced 575 k tonnes of prime billets in 2005, 668 k tonnes in 2006, 733 k tonnes in 2007 and 786 k tonnes in 2008. NASCO performance has been very consistent and the record highest monthly production was 77 k tonnes in January 2008.

The scrap handling operations include 4 scrap charging buckets on mobile scrap bucket carriers with weigh capability being filled by two overhead gantry type cranes with individual hoists, one grab (20t) and one magnet (16t) on both cranes.

Siemens VAI supplied the Electric Arc Furnace (EAF), the Ladle Refining Furnace (LRF) and participated in the overall engineering of the project from the plant layout stage. The batch size for the plant overall design was 80 t but due to the other pieces of the second hand equipment which were utilized the plant capacity was restricted for a planned 18 months with a batch size of 65 t. In order to reach the rated performance of the plant of 29 heats per day at 65 t of billet each it was decided to increase the EAF volume by extending the upper shell.

NASCO consists of following Plant Complexes :

- Electric Power Lines, Sub Station, SVC and Distribution System
- Scrap Yard
- EAF with 100 Metric Ton tap weight
- Ladle Refining Furnace (LRF) of 100 Metric Ton Capacity
- Billet Continuous Casting Machine (CCM)
- Dust Collection System (DCS)
- Auto Alloy Addition System
- Water Complex
- Testing Laboratories

NASCO is proud to be the latest and most technologically advanced addition to Al Tuwairqi Group's steel making facilities. Commissioned in the shortest possible period of time, NASCO with its state-of-art equipment, strong MIS, level 3 automation and effective cost control initiatives, provides strategic backward integration for our Flagship steel rolling mill - Al Ittefaq Steel, to ensure the continuous and uninterrupted supply of high quality cost-effective billets.

It is our policy to have a reputation in the Steel Industry that the company which provides cost-effective quality products to customers. **This we achieve by:**

Implementing an effective Quality Management System and carry out continual improvement in all aspects of our business

Involving each NASCO individual to take responsibility towards quality as it is integrated in our organizational work culture

Creating, stimulating and rewarding work environment

Organizing the training programs to up grade the skills

Enhancing the productivity and efficiency by investing in latest technology

Placing equal emphasis on the drivers of the business
- Safety, Quality, Customer Satisfaction and Cost

AL FAISAL STEEL PRODUCTS CO. (FSPC)

Over the season of massive developments in the Kingdom of Saudi Arabia, the steel industry has become the most potential contributors in strengthening the Kingdom's economic policy. The foundation of Al-Faisal Steel Products Company (FSPC) in the year 2003 plays significant roles since the time it started its commercial operations.

"Company's operations have expanded to keep pace with growing domestic market needs. Sales offices have been Established throughout Saudi Arabia including Dammam, Riyadh and Jeddah. In 2006 Al-Faisal Steel Products Company Established a production unit in Makkah to have better customer services in western province. FSPC is the largest down Stream Company in the region equipped with State-of-the-art production facility to fulfill all customers' requirements."

Al-Faisal Steel Products Company became the first domestic downstream steel producer to be certified to ISO 9001-2000. Al-Faisal is proud of its achievement and recognizes that ISO 9001-2000 is the platform for which total quality management means.

OUR PRODUCTS

1. Wire mesh (Black, Epoxy coated, galvanized)
2. Cut & Bend
3. Cold Rolling
4. Straight & Cutting
5. Fusion Bonded Epoxy Coating
6. Spring Wire
7. Galvanized Wire
8. PC strand

ANNUAL PRODUCTION

90,000 MT
288,000 MT
100,000 MT
240,000 MT
300,000 MT
72,000 MT
12.5,000 MT
20,000 MT

DIRECT REDUCTION IRON CO. (DRI)

Al Tuwairqi Holding Co., has embarked upon the integration of infrastructure for an integrated steel plant. The route to achieve this is thru DRI (Direct Reduced Iron), with a backward integration of Pelletisation Plant in near future. Since February 2005, the blueprint for achieving this has come in to place as the 2 DRI modules of Corus at Mobile (USA) were purchased; dismantled; transported to Saudi Arabia and commissioned in May 07' and November 07'.

These 2 modules operate on natural gas based MIDREX technology; a proven DRI technology which has more than 64% world market share. These modules are up graded to produce more than 1.5 million tons of DRI annually. After the commissioning in 2007, these modules have produced almost 700,000T of DRI. Most of the DRI was used in-house in NASCO steel plant for making Billets, but a significant amount was sold in Domestic and Export segment also. A unique facility of "Bagging" the Cold DRI has been developed by the co. to market the DRI product in a very safe and environment friendly manner. This facility has proven as the most economical technique to transport the DRI without any fire hazard and has been appreciated by the Domestic Customers.

Till middle of the year 2008, world has seen the most demanding market of steel, but there after the situation has dramatically changed in resulting a lowest demand of steel by end of the year. However, the demand for DRI as a scrap substitute for making quality steel is also tagged with the steel; more the steel demand; higher will be the use of DRI. This is the reason that with increased demand of Steel, world DRI production was expected to increase more than 56 million in 2008. There has been a very significant increase in DRI production capacity through Coal based Rotary Kiln process, which has happened because of non-availability of Natural Gas due to scarcity as well as high cost.

The process of DRI making aims to remove oxygen from iron ore Pellets/ Lumps. When that occurs, the departing oxygen causes micro pores in the ore body making it porous. The final product, when observed under a microscope, resembles a honeycomb structure looking spongy in texture, hence the DRI is also called as SPONGE IRON. The quality of DRI is primarily ascertained by the percentage of metallization (removal of oxygen), which is the ratio of metallic iron to the total iron present in the product. The metallurgical quality of DRI as to be produced at DRIC is as shown below:



شركة المنتجات الكهربائية الدولية
The International Electrical Products Co.
TIEPCO

THE INTERNATIONAL ELECTRICAL PRODUCTS CO. (TIEPCO)

First company in the region among switchgear manufacturers to obtain ISO 9001 – 2000 certification. Electrical Division of Al Tuwairqi Holding is one of the pioneers in the Switchgear Industry in the kingdom of Saudi Arabia.

It started its manufacturing activities in 1987 for the Medium and Low Voltage Switchgear. In 1998 the premises was upgraded to build a new factory with the name "The International Electrical Products Co. (TIEPCO)" in order to stand at par with the quality products of competitors, mainly multinationals.

Within short span of time since inception of its new plant TIEPCO is now enjoying status of approved manufacturer for Saudi Electricity Company for numerous products like Metered CB Ring Main Units, Ring Main Units, Package Substations and Relay Control Panels. For Saudi Aramco TIEPCO is the approved manufacturer of Metal Clad Switchgear and Relay and Control panels. For government ministries and departments and for the industrial and building sector TIEPCO is also supplying value added Metal Clad Switchgear, Protection & Control Panels, SCADA, RTU and Automation Panels.

TIEPCO has "Technology Centre" for the Engineering/Design of Protection, Control & Automation Solutions. Furthermore TIEPCO is providing system integration services through this wing.

The state of the art factory is spread over an area of 11,250 m² and is equipped with most modern CNC machines for sheet fabrication work required to manufacture a wide spectrum of Low and Medium Voltage Switchgear, Control and Protection Panels, Automation Panels and Package Substations etc.

Factory also houses the facility for "Electro-static Painting".

TIEPCO has the capability to produce Copper busbars in different shapes & sizes thru NOVA Press machines as per customize requirement, and our TIN PLATING plant facilitates the in house tin-plating.

TIEPCO is equipped with all necessary Testing Equipments to perform all routine tests as per IEC standard.

Additionally, we have developed IN-HOUSE capability to perform some of the TYPE TESTS e.g. Temperature Rise Test, IP Test (for the verification of ingress of Water), Mechanical Impact Test & Sound Level Test etc.

WE ASSUME RESPONSIBILITY FROM BASIC ENGINEERING TO PRODUCT SELECTION AND INTEGRATION AND HENCE COME UP WITH COMPREHENSIVE SOLUTIONS FOR OUR VALUED CUSTOMERS.



OUR PRODUCTS & SERVICES

RELAY & CONTROL PANELS : Transformer Protection, RTCC Panels, O/H T/L Protection Panels, Line Cable Protection, Busbar Protection, Generator Protection, Motor Protection, ABTS Panels, Data Retrieval Panels, CB Control Panels, Annunciation Panels, Synchronizing Panels etc.

RELAY & CONTROL CUBICLE : TRP & TCP

AUTOMATION & CONTROL SOLUTION: Substation Automation (IEC 61850) & Industrial Automation

MV METALCLAD SWITCHGEAR (IEC) : 17.5 kV, 630A to 3150A, Up to 40 KA

MV METALCLAD SWITCHGEAR (ANSI) : 4.76kV, 63kA // 15 kV, 63kA // 38 kV up to 40kA

MV METAL ENCLOSED SWITCHGEAR : 17.5kV, 630A, 21 kA and 36 kV, 630A, 25kA

LOW VOLTAGE SWITCHGEAR : Up to 660V, 6000A, 65kA

PACKAGE SUBSTATIONS : 13.8 & 33kV, 100 to 3150kVA

SHEET METAL WORK: Manufacturing of complex sheet metal parts including cable Trays

SUPERVISION OF TESTING & COMMISSIONING :
:Qualified & Experienced engineers are capable to provide Testing & Commissioning services for supplied TIEPCO equipment



وحدة تدوير المعادن
Metal Recycling Mill

METAL RECYCLING MILL (MRM)

Apart from the Scrap movement, we do have team of professional, latest equipments and infrastructure for Port operation which include the movement of DRI pallet more than 2.5 mil ton per annum. The whole operation have a sequence of Discharge of Oxide pallets from Vessel, Transportation from Jetty to Port Yard, Storage at Port Yard and bringing to the DR plant with our own Logistic and Transportation arrangement round the clock. We do have our own Berth at Dammam port which is facilitated with 2 nos. of Ship Un loader for discharging and loading of Vessel, Storage Yard with Conveyor system from Jetty to Port Yard, Site offices, Maintenance Shop and Ware house.

We do have a set up Transportation with a fleet of more than 200 trucks of Volvo and Actros (Mercedes Benz) which is taking care of Raw material, Semi Finish and Finish product movement of Oxide Pallet from Port to DR plant, Scrap from MRM to Melt shop, Billet from Melt Shop to Rolling Mill and Rebar from Rolling to Ware house and Customers.

Within the MRM facility we have the facilities of maintenance with the latest equipment, machines, tools and tackle under the work shop to maintain the equipments and fleet.

With the above set up, MRM is capable to handle about 3.5 million tons of Raw material and about 2 million tons of semi finish and finish product. The following figures are for the recent years for the handling of raw material, semi finish and finish product.



Scrap Receipt 800,000 tons
Scrap charge to furnace 740,000 tons
Scrap processing 98,000 tons
Scrap inter-transfer 142,000 tons
Imports 103,000 tons
Handling of Oxide Pallet Tons Nil 365,000
Movement of Billet Tons Nil 740,000

PORT OPERATION

With the aim of integration of steel plant, 2 modules based on natural gas operation of MIDREX of DR plant for more than 1.5 mil ton/year have been installed in recent months.

To fulfill the requirement of raw material of DR plant for Oxide Pallet, Iron ore, Melt shop requirement for Scrap, Palletization plant requirement for Iron ore, Port Operation set up is on process which is equipped with 2 ship un-loader each of unloading capacity of more than 2000 tons/hrs with the conveyor system up to stacking yard at Dammam Port.

To transport the Raw material from Dammam Port to the DR plant, Melt Shop a fleet of 40 heavy duty tipper trucks are in operation for round the clock to handle the requirement of Pellet which is more 2.5 mil ton per annum. Stacking, Handling and loading of material during and after the shipment are carried by heavy equipments like front loader.

Report From the Western Region

It is my pleasure to report the following major events that took place during 2008–09 of the newly formed IEP–SAC Western Region. Our inaugural ceremony was held in Jeddah on 01 February 2008. Dr. Shahid Sayeed Khan from Pakistan Railways gave a lecture on Management of Quality for Infrastructure Construction emphasizing the need for, and importance of, quality management in the manufacturing and production sector in general and the construction sector in particular. “If you look at the monuments around the world that have stood the test of time, you will realize the dedication and integrity with which the engineers have built them,” Dr Khan noted. Engr Asrar Mufti, Riyadh–based Project Director Schneider Electric, spoke on “Technology for Energy Efficiency” called for saving energy, which is expensive and scarce. “In the last 50 years, energy consumption has trebled and in the next 25 years it will further double, so we have to save 30 percent of the energy we use to meet the challenges posed,” he said. Another speaker, Engr Salman Qureshi, General Manager, Gulf Power Distribution, spoke on Industrial and Power Crisis in Pakistan and the Role of Individuals, reminding that the energy issue was more important than any other issue. IEP–SAC–WP Chairman Engr Abdul Aleem Khan, who presided the event, gave an overview of the vast development Pakistan has made in various fields. The Chief Guest His Excellency the Ambassador, Islamic Republic of Pakistan, Admiral (R) Shahid Karimullah, urged the Pakistani engineers to realize their responsibility and play an effective role in tackling today’s complex issues. He said he had been a witness to the marvelous achievements of Pakistani engineers in the missile, space and nuclear technology and they were capable of achieving excellence in whatever they did. “They can acquire top management positions by the dint of their hard work and devotion,” remarked the Ambassador. On 19 May 2008, IEP–SAC–WP, organized the launching ceremony of the book Muslim Civilisation—Causes of Decline and Need for Reform by the Faisal–Laureate Dr Mohammad Umer Chapra. The venue was Jeddah Hilton. The chief guest on this occasion was Jeddah Mayor HRH Prince Meshaal Bin Majed Bin Abdulaziz who represented the Governor, HRH Khalid Al–Faisal who could not attend due to some urgent commitment. The keynote speaker was His Excellency the Ambassador, Admiral (R) Shahid Karimullah. Other guests included Mr. Rauf Aziz, Head of Jeddah Chamber of Commerce, Consular staff of the Jeddah Consulate, and Mr. Abdur Rauf Siddiqui, Sindh’s Minister of Commerce and Industry, prominent Saudi and Pakistani dignitaries, community members and engineers at large. The function was inaugurated by Engr Jaleel Hassan, Ex–Chairman IEP–SAC.

Mr. Abdur Rauf Siddiqui who was on visit to Kingdom joined as the Guest of Honor praised Dr Chapra’s book and Ambassador Shahid Karimullah’s concept of global leader for Muslim Ummah to address the issues and solve them by dialogue.

Engr Abdul Aleem Khan
Chairman IEP–SAC–WP

IEP-SEC Local Council Western Region



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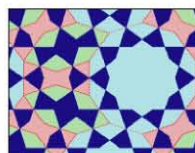
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The 20th Century Quasicrystalline Geometry Found in Medieval Islamic tiles

Researchers in the US have found 15th Century examples that use the concept of quasicrystalline geometry. This indicates intuitive understanding of complex mathematical formulae, even if the artisans had not worked out the underlying theory, the study says. The discovery is published in the journal Science. The research shows an important breakthrough had occurred in Islamic mathematics and design by 1200. "They made tilings that reflect mathematics that were so sophisticated that we didn't figure it out until the last 20 or 30 years," Harvard's Peter Lu said in an interview. The Islamic designs echo quasicrystalline geometry in that both use symmetrical polygonal shapes to create patterns that can be extended indefinitely without repetition. Mr Lu became interested in the subject while travelling in Uzbekistan, where he noticed a 16th Century Islamic building with decagonal motif tiling. Mr Lu, who designs physics experiments for the International Space Station, was in the region to deliver a lecture in Turkmenistan. Islamic art traditionally uses a mixture of calligraphy, geometric and floral designs because of a prohibition on the portrayal of the human form. (Courtesy: BBC).





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- Installation of Piping, Structures, Static as well as Rotary Equipments



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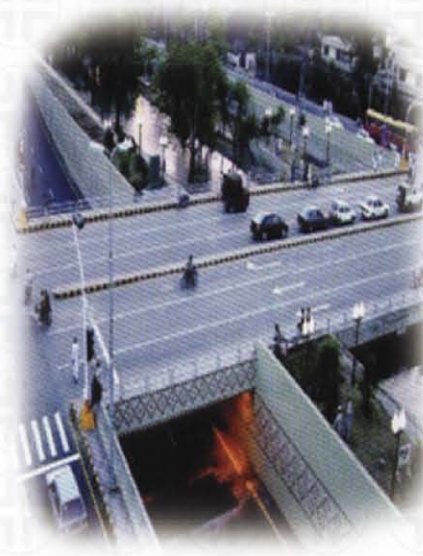
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Please Write for **YOUR** Journal

IEP-SAC Journal is published every year at the occasion of its Summer Annual Technical Seminar. The Editorial Board welcomes articles for publication which could further the Journal's mission to keep professional engineers abreast of current trends and practices in engineering sciences and technology and to promote exchange of scientific and technical knowledge. Articles should be written in a serious but not overformal academic style at a level informative to other workers in the area and also accessible to engineers active in other fields of engineering.

The Editorial Board solicits manuscripts of the following types from prospective authors:

- a. "Review" type papers suitable for reading by practicing engineers to give a first-class introduction to a subject with which they are not familiar.
- b. Articles presenting key features of some new technology or system that is of general engineering interest.
- c. Articles taking a new look at old problems readable by those outside the field.
- d. Articles for the specialist recording an advance in the field, but readable by non-specialists also.

Scope

Broad interest articles pertinent to any discipline of engineering or related fields.

Manuscript Requirements

1. Papers can be 3000 words in length excluding diagrams and tables.
2. A short abstract of 150 words should be provided.
3. Manuscript may typically include five or six illustrations. These along with captions should be inserted at the appropriate places within the manuscript.
4. SI units should be used throughout except those allowed by consensus within the scientific and engineering community, namely, minute (symbol min), hour (h), and day (d) for time; degree (°), minute (′), and second (″) for plane angle; liter (l, L) for volume; and tonne (t) for mass; electron volt (ev), unified atomic mass unit (u), baud (Bd) and bit (bit) and certain other highly specialized units are acceptable. Please note that such non-SI units as nautical mile, knot, angstrom (Å), are (a), hectare (ha), barn (b), bar (bar), gal (Gal), curie (Ci), roentgen (R), rad (rd, rad), rem (rem), kilo-, mega-, giga- etc bytes are acceptable to the scientific community only temporarily.

Refereeing

Acceptance of manuscripts is subject to peer review by the Editorial Board or other reviewers and conditional upon revisions made in light of comments from the review process. Authors are nevertheless responsible for the accuracy of statements made in the paper. Where applicable, authors are also responsible for obtaining clearance from their employers.

Due Dates

Articles should be submitted to the members of the Editorial Board electronically no later than 31 March 2010. Please ensure that IEP-SAC acknowledges with the receipt of the manuscript.



IEP-SAC
**Technical
Seminar**
**15th January
2009**

Recent Trends in Power & Water Supply

Its central theme is based on a strategic shift in the focus of manufacturers of goods from capital goods to provisioning of integrated systems and services (ISS) solutions that meet particular business requirements. Customers (governments) thus withdraw from non-core activities they previously undertook internally and suppliers move up the value system into provisioning of the services, such as maintenance, life cycle support, financing and operations.

Recent Trends in Power & Water Supply

IEP – SAC Technical Seminar 15th January 2009

Contents

- Alternative Service Delivery Models
- The rational for Change
- The Saudi Initiative
- Success of Saudi Programme/few Examples
- What Next? + Impact of the Credit Crunch
- Implications for the Engineering Profession
- Introduction to ACWA Power International



1

Water & Power Services

- Essential services for the health and wealth of mankind.
- Technology needs to be applied and physical assets need to be built (capital Expenditure) and operated (Operation and maintenance expenditure) to deliver these services in a reliable manner at an adequate quantity.
- Unlike many other human Endeavour, these services require significant upfront expenditure to build the plant and associated infrastructure; and
- Quite often needs a reasonable amount of ongoing expenditure to operate and maintain the plant and infrastructure.

2

Contents

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1

The Rational For Change

- While albeit they are both essential commodities, water and power are just that like rice, wheat or clothing.
- Governments by definition are structured to govern; make policy, create level playing field, regulate and monitor.
- Private sector is geared to produce goods and services efficiently.
- Private sector adopts a more rigorous approach to understanding and managing risks.
- The ownership and associated "profit" (and "financial loss") motive provides a significant incentive to deliver.

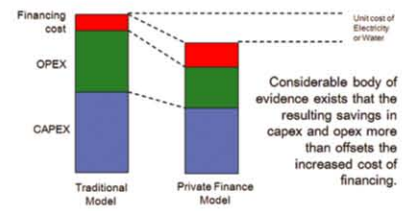
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Private Finance Model: The Rationale



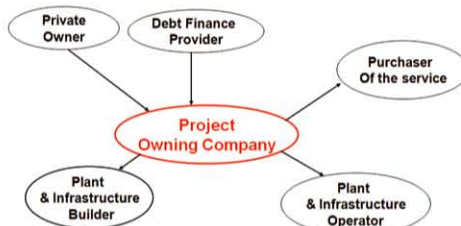
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Private Finance Model /The Rationale



1

The Private Finance Model



1

Contents

- Alternative Service Delivery Models
- The rational for Change
- **The Saudi Initiative**
- Success of Saudi Programme/few Examples
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- Implications for the Engineering Profession
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1

Recent Trends in Power & Water Supply

IEP – SAC Technical Seminar

15th January 2009

The Saudi Initiative

- Till 2004 Water & Power was provided by four essentially Government Owned entities.
 - Bulk water was/is produced by Saline water Conversion Company (who also co-generate power and sell to SEC).
 - Electricity is generated by Saudi Electric Company.
 - ARAMCO produces both water & power for it's own consumption.
 - Marafiq produces water and power (in addition to also purchasing from SWEC and SEC) for use at the two industrial cities.
- In 2003 HH the King of Saudi Arabia opened 24 sectors for greater private sector participation and water & power was targeted as a priority sector to increase the involvement of the private sector.
- To kick start the process the Government decided to initiate a pipeline of 4 projects to increase bulk water and power capacity.

9

Contents

- Alternative Service Delivery Models
- The rational for Change
- The Saudi Initiative
- Success of Saudi Programme/few Examples
- What Next? + Impact of the Credit Crunch
- Implications for the Engineering Profession
- Introduction to ACWA Power International



10

Supreme Economic Council Resolution 5/23

- The creation of Water & Electricity Company (to be owned 50/50 by SEC and SWCC) to be the single buyer of privately produced water and power through the first 4 projects.
- To give confidence at the start the Government will hold a 32% stake (using the Public Investment Fund) and SEC 8% in the Project Company
- The balance 60% will be held by the private sector developers
- Transactions will be Build, Own, Operate only and not Transfer
- Tenders for the projects will be assessed according to five principal criteria (price, capacity, Saudi employment, technical performance and the use of Saudi goods and services)

11

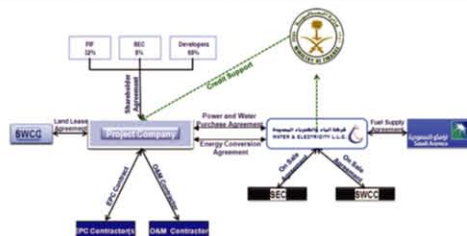
Shuaibah IWPP – Basic Detail



- 900 MW Crude Oil fired Power Plant + 880,000 m³/d Multi Stage Flash type desalination plant.
- Located 110 km south of Jeddah.
- Developers: ACWA Power Int. + TNB, Malakoff & Khazanah.
- EPC Contractor: Siemens + Doosan.
- Project Cost: US\$ 2.45 Billion.

12

WEC Contract Framework



13

Anchor of the Saudi IWPP Programme

- Shuaibah the first major Government Sponsored IWPP. An untested proposition
- WEC the promoter a new company + transaction at US\$ 2.4billion very large
- One compliant bid with tariff in anticipated range was submitted on the due date.
- The transaction proceeded to Financial Close in record time
- Lender community embraced the transaction. 52% over subscription of US\$ 1.8 billion of debt.
- Project Commenced in January 2006.
- ICOD was targeted for Feb 2009 and PCOD for July 2009
- In fact we achieved ICOD in December 2008

14

Other regulatory Reforms

- Electricity Sector Reforms underway.
 - Generation separated from Transmission and distribution.
 - A regulator has been established: Electricity Regulating Authority (ECRA).
- A Water Sector Reform Bill has been passed.
- Decision already taken to bundle all of the existing assets of SWCC (desalination and the desal/power cogeneration assets) into 7 packages and sell to the private sector starting in last quarter 2009.
- A key related issue protection of the Environment is also being addressed. Regulator PME (Presidency for Meteorology and Environment) is being strengthened.

15

Marafiq IWPP – Basic Detail



- 2745 MW Gas Fired Power Plant.
- 800,000 m³/d desal plant.
- Water and Power produced will augment supplies to the Jubail Industrial City.
- Developers: ACWA Power Int. + Suez Energy + Gulf Investment Corp.
- EPC: GE + Sidem + HHI.
- Project Cost: US\$ 3.3 Billion.

16

Recent Trends in Power & Water Supply

IEP – SAC Technical Seminar
15th January 2009

Creating Financial Value to the Economy = Value ✓

Bid Tariff for Marafiq

Marafiq		
Developer	Power	Water
Suez/ACWA/GIC	5.71	311.25
IP/Sumitomo/Oger	6.99	307.50
Mitsui/KEPCO/NPC	7.50	273.75

- In net present value terms SAR 1.8 Billion is the difference between the lowest bid and the second lowest bid

18

What Next? Demand remains significant in KSA

	Year 2007	Year 2024
Population (Millions)	27	40
Power Demand (MW)	32,000	59,000
Water Demand (m ³ /day)	6,000,000	10,000,000

- Pent-up demand /under investment in the Past.
- Population growth.
- Aggressive Industrial Expansion.
- Existing assets nearing end of their economic life.



22

Fujairah 2 IWPP vs. Marafiq IWPP

	Fujairah 2	Marafiq
Capacity	2000MW +130 mgpd	2750MW+175 mgpd
Fuel	Gas	Gas
PWPA Term	20 years	20 years
Transfer at end of term	No	Yes
Private sector /Public sector ownership	40/60%	60/40%
Local Private ownership	0%	40%
Project cost	US\$ 3 billion	US\$ 3.4 billion
Funding Structure: Debt/Equity	80/20%	80/20%
LEC (US cents/kWh)	2.97	1.66
LWC (US\$ /1000 gal per day)	3.72	3.723

19

Opportunity Pipeline is long

- WEC Ras Azzour (1100 MW + 1,000,000 cum/day) BOO to sell water & Power to this Government of Saudi Arabia owned Company for 20 years. Contract is expected to be awarded in Feb 09. ACWA lead consortium with KEPCO as the partner is one of two bidders left in the race. (US\$ 5.5 Billion transaction)
- SEC Rabigh IPP (1200 MW) – BOO to sell Water & Power to Saudi Electric Company. Consortium Lowest Bid already submitted. ACWA lead Consortium with KEPCO as our technical partner submitted the lowest tariff offer. Evaluation underway. We expect Contract award also in February 09. (US\$ 2.3 Billion transaction)
- Marafiq Yanbu (1700 MW + 150 000 cum/day) BOT to sell water & Power for 20 years – bid under preparation – US\$ 3.5 Billion transaction

21

Fujairah 2 IWPP vs. Marafiq IWPP

	Fujairah 2	Marafiq
Transfer at the end of term	No	Yes
LEC (US cents/kWh)	2.97	1.66
LWC (US\$ /1000 gal per day)	3.72	3.723
Fuel Price	5.9 SAR/KJ	2.95 SAR/KJ
Type of Contract	BOO	BOOT

Saving in terms of NPV SR 3.0 Billion*

* Saving calculation include adjustment for fuel price difference but not for the fact that the whole of the capital cost has been written off in the 20 year PWPA term.

20

Opportunity Pipeline – 2009 and beyond

- SEC PP11 IPP 2000 MW – BOO - RFP in March 09 (US\$ 3.5 Billion).
- SWCC Asset Sale 1st of 7 projects (each to be tendered every 9 months starting in April 2009) to buy existing power and desalination plants owned by Government of Saudi Arabia and to rehabilitate and expand them. Each project will be worth over US\$ 2 Billion
- SEC has announced a list of 8 other IPPs to be contracted over the next 5 years.
- SEC GenCo sales. The 4 bundles of 8000MW each
- Ras Tanura Integrated Petrochemicals project – Power, water and steam outsourcing contract.
- Jizan Refinery & Petrochemical Complex Power, water and steam outsourcing.
- Maaden Aluminum Smelter – 1400 Power on a utility outsourcing package.

24

Contents

- Alternative Service Delivery Models
- The rationale for Change
- The Saudi Initiative
- Success of Saudi Programmes/few Examples
- What Next? + Impact of the Credit Crunch
- Implications for the Engineering Profession
- Introduction to ACWA Power International



25

Impact of the Credit Crunch

- The projects are typically funded with 20% equity and 80% debt and each is a multi billion US\$ transaction.
- Yes, there is a credit crunch, but we do not expect it to impact significantly on the IPP IWPP programme
- Why?
 - The general consensus amongst financial institutions is that the limited recourse project finance framework remains a bankable structure.
 - The issue is lack of liquidity in the global financial market. But there is a significant financial capacity in the Kingdom.
 - KSA remains highly creditworthy and this framework on many of the Saudi projects have sovereign credit support.
- We are working on US\$ 2.3 Billion Rabigh IPP financing right now. That shows us that we are not being unrealistically optimistic.

26

Recent Trends in Power & Water Supply

IEP – SAC Technical. Seminar
15th January 2009

Contents

- Alternative Service Delivery Models
- The rationale for Change
- The Saudi Initiative
- Success of Saudi Programme/few Examples
- What Next? + Impact of the Credit Crunch
- **Implications for the Engineering Profession**
- Introduction to ACWA Power International



3

What have we done?

In the last 48 Months:

- Assembled consortiums and Bid the first 4 IWPP transactions launched in the Kingdom of Saudi Arabia and have won all four.
- On a negotiated basis the first transaction has been expanded to deliver more water; structured as a separate project.
- The Five projects total 4800MW and 2.4 Million Cum per day of desalinated water, representing a total of US\$ 9.6 Billion of investment.
- ACWA Power led three of the five transactions as the Lead Developer.
- One project completed. Four are under construction and are on schedule.
- Rabigh IWSP now operational. First units of Shuaibah IWPP has already started to dispatch desalinated water and power.

4

The Implications for the Engineering Profession

- Focus on "whole Life Cost". Thus balancing capital and operating costs.
- This means willingness to compromise – not normally accepted by the pure Engineer who is inclined to focus on the most robust technical solution.
- A significant component of value through the "privatized services delivery model" comes from allocating risks to those who are best equipped to manage those risks. Thus need to focus on understanding and evaluating risks and on compartmentalizing risks through appropriate contract framework.
- At the project owner level, we focus on FUNCTIONAL specification. I.e.: specify output not input.
- Utilizing private finance also imposes strict discipline on environmental impact identification and mitigation.

5

ACWA Power – A snapshot of its projects

- | | |
|--|--|
| Shuaibah Phase III IWPP <ul style="list-style-type: none"> • Project cost: SR 188 million • Power capacity: 900 MW • Water capacity: 880,000 m³/day • Contract type: 20 year PWP based on BOOT • PCOD: July 2009 • Partners: TNE/Malakoff/Nohazana | Rabigh IWSP <ul style="list-style-type: none"> • Power capacity: 260 MW • Water capacity: 5,580 t/hr (134,000 m³/day) • Steam capacity: 1,230 t/hr (29,500 m³/day) • Contract type: 20 year IWCA based on BOOT • PCOD: June 2008 • Partner: Marubeni/JGC/Itochu |
| Shuaibah Expansion IWP <ul style="list-style-type: none"> • Project cost: SR 875 million • Water capacity: 150,000 m³/day • PCOD: February 2009 • Partners: TNE/Malakoff/Nohazana | Marafiq Jubail IWPP <ul style="list-style-type: none"> • Project cost: SR 12,580 million • Power capacity: 2,743 MW • Water capacity: 800,000 m³/day • Contract type: 20 year PWP based on BOOT • PCOD: March 2010 • Partner: Suez Energy International/GIC |
| Desalination Barges <ul style="list-style-type: none"> • Water capacity: 50,000 m³/day • PCOD: First quarter 2008 | Shuaibah Phase II IWPP <ul style="list-style-type: none"> • Project cost: SR 6,866 million • Power capacity: 850 MW • Water capacity: 212,000 m³/day • Contract type: 20 year PWP based on BOOT • PCOD: December 2010 • Partner: Mitsubishi Corporation/GIC |



SR: Saudi Riyal; PWP: Power and Water Purchase Agreement; BOOT: Build Own and Operate; B2T: Build, Operate and Transfer; PCOD: Project Commencement/Operational Date; MW: Mega Watt (Energy); t/hr: Tons per Hour; Independent units: Stand alone units/Project

6

Contents

- Alternative Service Delivery Models
- The rationale for Change
- The Saudi Initiative
- Success of Saudi Programme/few Examples
- What Next? + Impact of the Credit Crunch
- Implications for the Engineering Profession
- **Introduction to ACWA Power International**



7

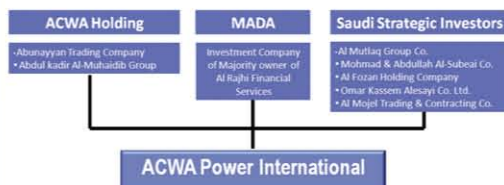
Thank you for your attention

Paddy Padmanathan
President & CEO
ACWA Power International



8

ACWA Power International - Who are we?



9



Engr Paddy Pamanathan

is based in Riyadh, KSA, and is the President & CEO of AcwaPower International, a company involved in several independent power and water projects in Saudi Arabia and Gulf countries. He holds a BSc in civil engineering from the University of Manchester and a post graduate qualification in engineering management from the University of Lancaster. He has 23 years experience spanning from design and construction of infrastructure to manage business units at ten international locations. Much of his experience in the last decade has centered on the development of power, water and wastewater projects based on concessions, BOT, BOO type of service delivery contracts utilizing the frame work of limited resource project financing.

10

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شركة هندسة الأرض للمقاولات

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Stone Columns



Bentonite Plant



Pipe Piling



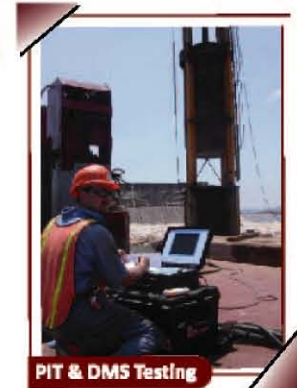
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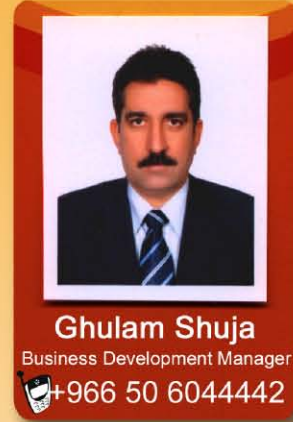


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SUSTAINABLE, HIGH-PERFORMANCE GREEN BUILDING DEVELOPMENT AND LEED GRADING

Earth's natural resources such as water, land and air cannot go on forever. The wise stewardship of these natural resources for continued growth and developments of all on this planet is the ultimate goal of implementing this new concept. The energy consumed in homes is responsible for over a quarter of all emission of CO₂, the main green house gas causing climate changes. Using energy more efficiently and cutting out wastage will reduce CO₂ emission as well as fuel bill. This paper presents some ideas about how one can help in planning and designing the buildings as well as in its operation and day-to-day life events in order to achieve the "greener living".

INTRODUCTION |

Change in climate is one of the grave issues that our planet is facing. "Climate change" refers to rise in earth's temperature over the past 100 year. Since 1900, the average temperature on the planet has increased by 0.74o C and sea level has risen by about 10 cm. This process of "climate change" is continuing and further global rises are expected, as well as more extreme weather events like flooding and draught cannot be ruled out. There is now very strong evidence that significant global warming cannot be explained by natural causes alone. Humans are changing the climate with their actions, especially through emissions of green house gases such as carbon dioxide. In some developed countries like UK, individuals are responsible for about 40 percent of emission of green house gases.

Some changes to the climate are inevitable, but there is still time to positively influence the future. One can help minimise further changes and adapt to the new situation through decisions and actions which are dependable and reliable. Greener living and sustainable development is an answer to this challenge. Using energy more efficiently and recycling and cutting waste will reduce CO₂ emission. In this paper steps are discussed to achieve the high performance green building development and code requirements for compulsory rating of all new homes in USA and other countries. Before discussing the various steps for "Greener living", some involved terminology is defined hereunder. [1]

Green

is most commonly used to describe the prudent use and application of natural materials that are found naturally in the environment. When discussing products, green basically means products that deliver the same or better performance, function, or

other benefits than a comparable product that uses more resources, contains more toxic materials, and/or has shorter lifecycle, [1, 4].

Sustainable

is making use of renewable materials that grow naturally and are replaceable or readily replenished. Sustainable design (also referred to as green design, eco-design, or design for environment) is the art of designing physical objects and the built environment to comply with the principles of economic, social and ecological sustainability. A widely used definition of sustainable development is: "Development which meets the needs of the present without compromising the ability of future generations to meet their own needs", [1, 4].

A carbon footprint

is a measure of the impact human activities have on the environment in terms of the amount of greenhouses gases produced, measured in units of carbon dioxide". These emissions contribute to accelerating global warming and climate change. The main greenhouse gas is carbon dioxide (CO₂), produced when we burn fossil fuels like coal, oil and gas for energy, [7].

Conservation

is generally defined as the practice of protecting against loss and waste and managing our natural resources, both renewable and nonrenewable.

Sustainable Green Building Development

The building and its technical system are planned simultaneously in an integrated architectural/engineering process complementing local sustainable design goals. In this regard the following four key areas can be identified, [3, 4].

i) Sustainable consumption and production: Changing the way products and services are

designed, produced, used and disposed of, in short, achieving more with less.

ii) Climate change and energy: Reducing greenhouse gas emissions whilst at the same time preparing for the climate change that cannot be avoided.

iii) Natural resources: Understanding the limits of the natural resources such as water, air and soil which sustain life.

iv) Sustainable communities: Looking after the places people live and work, for example, by developing green, open spaces and building energy-efficient homes. In order to achieve the targeted goals, following forward steps are needed:

Design Integration:

By integrating the design goals with technical systems criteria and strategies, specific technologies can be implemented in an integrated fashion to make the selected strategies work with each other for greater results thereby meeting or exceeding the design and sustainable goals for the project.

Local microclimate:

For initiating the design of any building project attention is required to look at the local microclimate for opportunities to utilize renewable resources to complement the buildings technical system and also look for opportunities to conserve natural resources by designing system that operate most efficiently within the local climatic conditions. This analysis includes the following items:

- * Weather data and general conditions.
- * Site geology and natural resources.
- * Water table location and conditions.
- * Renewable energy resources
- * wind, solar, geothermal.

Technical System High Performances Strategies:

The energy consumed in homes and buildings is responsible for over a quarter of

GREEN BUILDING DEVELOPMENT AND LEED GRADING

all emissions of CO₂, the main greenhouse gas causing climate change. Using energy more efficiently and cutting out wastage will reduce carbon emissions as well as fuel bills. Following energy saving tips can be considered [2, 3, 4]:

i) Limit building environmental heat gain and loss due to the outdoor conditions through a high performance exterior envelop that maximizes daylight opportunities allowing the reduction of electrical usage for internal building lighting.

ii) Utility systems should be planned to generate the highest tolerant service temperature that is energy neutral to the project and distribute at the lowest pressure practical to minimize operating cost.

iii) System should not be oversized based on prescriptive criteria but "right-sized" to have peak operating efficiency at actual building load based on the measured usage of past projects.

iv) Utility distribution system should have variable flow capability to limit electrical usage and track the building load with the minimum amount of power possible. Energy metering should be an integral part of the design to track the buildings performance and assure that it does not degrade its energy saving potential over time.

v) Minimize energy usage to drive ventilation fans. Provide a low-pressure air distribution system to limit fan power.

vi) Provide space cooling and heating with distributed water based system and supplemental fan system driven by the building occupants' ventilation requirement.

vii) Utilize chilled water for passive cooling sources without fan power. Water to air heat transfer is 3,500 times more efficient than air-to-air heat transfer.

viii) Indoor air quality (IAQ) monitoring, technical system monitoring and metering should be planned so that over a period of time systems still operate at their designed energy performance and the indoor air is at a level to maximize human health benefits and productivity.

ix) Outside air should be pre-conditioned (cooled, heated and dehumidified) at mechanical floors in the building before being distributed. This limits air distribution

vertically to only what is required for ventilation purposes.

x) Water harvesting: Water harvesting is the collecting water from unconventional sources, processing it as appropriate and storing it for use. Unconventional sources could be rain water collected from building roofs, parking lots and other hard surfaces or grey water from non-fecal-bearing waste as such from lavatories, sinks, showers, and automatic clothes washers. The stored water could be used directly for irrigation, fire protection and for fixture (W.C. and urinals) flushing.

xi) Water conservation: Potable water is scarce, expensive and is getting more expensive. Municipal water treatment is getting costly and requires chemicals. It is therefore mandatory to conserve these resources and avoid contaminating the supply. To reduce the use of potable water in both the buildings interior and exterior, technology has developed automatic fixtures, low-flow fixtures, waterless urinals, high-efficiency irrigation, and native and adopted landscape plants. Water saving fixtures includes:

- * Infrared faucet sensors.
- * Delayed shutoff, spring-action, and push rod faucets.
- * Flow restrictors.
- * Metering faucets (0.25 gallon per cycle).
- * Dishwashers using 10 gallons or less per cycle.
- * Dual-flush toilets.
- * Vacuum assist toilets.
- * Another option is the point-of-use water heater, which is a small, instant water heater located near sinks or showers. It saves energy as well as saves water, as less water is used waiting for hot water to arrive. Its short pipe runs offer less energy loss and use less material. These heaters are not ideal for high-use locations however for homes LEED

[1] rating system includes credits for designing a home with all the plumbing fixtures located near one another. The end result is less piping used in construction, which means a simple, energy-efficient tankless water heater works very well in meeting the demands of the house.

xii) More energy saving steps in homes:
* Turnoff your appliances, don't leave them on standby.

- * Washing clothes at 30o C can be just as effective for a normally soiled load.
- * Run your washing machine or dishwasher with full load.
- * Avoid tumble-drying. Dry cloth outdoor when possible to save money and energy.
- * Defrost your freezer regularly and avoid putting hot food in the freezer.
- * Turndown your thermostat and immersion heater temperature by one degree – the saving will be significant about 10%.
- * Boil a kettle with only as much water as you need.
- * Cover pots and pans when cooking – they will boil a lot quicker.
- * Rechargeable batteries cost about twice as much as conventional ones, but can be used hundred of times.
- * Use energy efficient light bulbs.
- * Consider using a microwave rather than a conventional oven if you are looking to heat up a small amount of food. This will help to save energy.
- * Fixing drips – A dripping tap or overflow can waste a lot of water (just 2 drips a second adds up to about 26 liters of water a day), but a new washer costs less than One Saudi Riyal and can be fitted in minutes.
- * Fitting aerator or spray ends to washbasin and kitchen sink taps can reduce water consumption up to 50%.
- * Turning off the taps when you are brushing your teeth or shaving can save five liters a minute. The more water used in our homes, the less is available in rivers, lakes and natural wetlands, as a result threatening wildlife and environment.



GREEN BUILDING DEVELOPMENT AND LEED GRADING

Environment and Sustainable Landscape

Climate change refers to shifts in the earth's temperature that have happened over the last 100 years. Since 1900, the average temperature on the planet has increased by 0.74o C and the sea level around the UK has risen by about 10 cm [6].

Most scientists agree that global temperature could rise between 1.1 and 6.4o C above 1990 levels by the end of the 21st century, depending on future emissions of greenhouse gases. If the rise is high, then changes are likely to be so extreme that it will be difficult to cope with them. There are likely to be more intense and frequent extreme weather events, like floods and hurricanes, and a future rise of up to 59 cm. in sea levels.

The World's Response To Climate Change

In 1998, the United Nations set up the intergovernmental panel on climate change (IPCC) to analyse and report on scientific findings. The IPCC's first report found that the planet had warmed by 0.5o C in the past century. It warned that only strong measures to halt rising greenhouse gas emissions would prevent serious global warming [3, 4].

In 1992, the Earth summit took place in Rio de Janeiro. Here the United Nations Framework convention on climate change (UNFCCC) was signed by 154 nations. It agreed to prevent "dangerous" warming from greenhouse gases and set voluntary targets for reducing emissions [1, 3].

In 1977, the Kyoto protocol was agreed. According to that protocol the UNFCCC agreed voluntary targets; Kyoto was the first international treaty to set legally binding emissions cuts for industrialized nations. It was signed by 178 countries and came into force in 2005.

In 2007, the IPCC confirmed that there is a greater than 90 percent chance that global warming over the last 50 years is due to human activity. It claimed that the planet had warmed 0.74 degrees Celsius since the beginning of the 20th century. At the UN climate change conference in Bali, also in 2007, all the world's nations agreed to negotiate on a deal to tackle dangerous climate change. The details are expected in the next two years. [2, 3, 4]

What one can do about climate change

Some changes to the climate are inevitable, but there is still time to positively influence the future. Everyone should contribute to minimize further changes by adopting the new situation through decisions and actions which are often quick and easy to put into practice. In this regard four key areas have been identified:

i) Sustainable consumption and production:

Changing the way products and services are designed, produced, used and disposed of. In short achieving more with less. Plan characterized by a reduction in the creation of CO2 emissions can be commitment to this strategy [3].

ii) Climate change and energy:

Reducing green house gas emissions, while at the same time preparing for the climate change that cannot be avoided [4].

iii) Natural resources:

Understanding the limits of the natural resources that sustain life, such as water air and soil.

iv) Sustainable communities:

Looking after the places people live and work, for example, by developing green, open spaces and building energy-efficient homes [6].

Sustainable landscape

Most people assume that all landscape architecture is sustainable because we are responsible for planting lots of trees, restoring ecologies and caring for the land. In reality the contemporary landscape architecture is also responsible for significant carbon emission.

Recently one landscape architect in New Zealand, with around 14 years experience, calculated that despite planting almost 54,000 trees in his career, he actually would have to plant another 120,000 trees in order to compensate for CO2 emission for which he was responsible. This striking figure highlights the misunderstanding that is commonly prevails [1].

Even for landscape architect, sustainability requires a fundamental change in attitude, enforced by the obvious effects of global warming. As pointed out earlier, the warming process has accelerated due to a period of massive economic growth, especially in developing countries with high populations that previously had a much smaller percapita carbon footprint. All of the people of the world must now do what they can to help reduce green house gas emissions and reduce the "heat island" effect of urban settlements.

There are thousands of ways in which we can help. Let's begin by considering the role we can play in site planning to encourage the marriage of built form and spaces between buildings. Under a carbon neutral or carbon positive regime, anything that

reduces the heat island effect will be beneficial as long as there are no conflicting downsides such as excessive use of water or energy to gain the reduction. Landscape architects can improve the sustainability of their designs by:

* Using plants that are adapted to places with extreme heat coupled with humidity. Plants not adapted to such conditions cannot cool themselves by transpiring which causes the plant to waste.

* Respecting site conditions like topography, mature vegetation and existing water courses to minimize the energy required to implement new design.

* Reduce the reliance on elaborate, unshaded water features that consume large amount of energy and water.

* Managing existing on-site soils so that they are sustainable through soil creation methods rather than bringing in huge amounts of dune sand to sites.

* Taking into consideration the embodied energy and CO2 when selecting hardscape materials (for example the CO2 cost of concrete is 4 tonnes per metric tonne while stone is 0.12 tonnes per metric tonne).

* Reducing the amount of material removed from sites that goes to landfill.

* Always planting for shade particularly along pedestrian corridors and near water bodies.

* Using planting to deflect hot summer winds from houses.

* Not "over-providing" lighting.

* Understanding where plant species naturally occur and the associations with other species. Plants have comfort zones so it is essential that plants are used in situations similar to their natural conditions or the conditions are modified by shade and shelter to create a comfort zone.

Plant selection and water consumption go hand in hand but it does require an extensive knowledge of plants to get it right. A properly designed Xeriscape can be lush, colourful and easy to maintain. The original meaning of the word "Xeriscape" was simply water wise, or water efficient landscaping. The preciousness of water needs to be emphasized along with its long history associated with the Middle East, the Muslim faith and Arabic garden traditions. As a claiming influence it can be employed to create areas of quiet and contemplation.

The LEED Rating System

LEED stands for Leadership in Energy and

Environmental Design. LEED is an ecology-oriented building certification program run under the auspices of the U.S. Green Building Council (USGBC). LEED concentrates its efforts on improving performance across five key areas of environmental and human health [1, 2].

- i) Energy efficiency
- ii) Indoor environmental quality
- iii) Material selection
- iv) Sustainable site development
- v) Water savings.

LEED rests on a collection of special rating system that applies to all kind of structures. Rating systems are available for new constructions as well as to existing buildings. The total rating points assigned by LEED are 69. The LEED for new construction rating system has four award levels [1, 2, 4].

- * Certified (26 to 32 of total 69 credits)
- * Silver (33 to 38 of 69 total credits)
- * Gold (39 to 51 of 69 total credits)
- * Platinum (52 or more of 69 total credits)

For details, readers are advised to refer to website: www.usgb.org. It deals with the site disturbance, materials, and transport of materials to the site, water usage, heat island effects and energy performance not only during construction but also for the continued life of development. In most developed countries, there are assessment systems that quantify the sustainability of new and refurbished buildings against a wide range of criteria to establish their degree of sustainability. These systems all have similar criteria, but contain different details tailored to suit the particular country in which they were developed and are used. For example, there is a compulsory rating of all new homes in England under the code for sustainable homes.

The Emirates Green Building Council (EGBC) has adopted a modified version of American LEED, called BSAT (Building Sustainability Assessment Tool) [5]. In this version the total rating points to be scored are increased from 69 to 72. This modification is mainly related to putting more emphasis on water conservation because of its scarcity in that region. In addition, adjustments have been made to the content and the weight given to other sections, to make the whole system more applicable to use in the U.A.E.

Conclusions

IPCC has confirmed that global warming over the past 50 years is due to human activity. It is reported that the planet had warmed by 0.74o C since the beginning of the 20th century. All the world's nations have agreed to negotiate on a deal to combat dangerous climate change. In this regard four key areas have been identified:

SUSTAINABLE, HIGH-PERFORMANCE GREEN BUILDING DEVELOPMENT AND LEED GRADING

- i) Sustainable consumption and production.
- ii) Climate change and energy.
- iii) Conservation of natural resources such as water, air and soil.
- iv) Sustainable communities. In this regard energy-efficient or sustainable green building development is a vital issue:

In the most developing countries, there are assessment systems that quantify the sustainability of new and refurbished buildings against a wide range of criteria to establish their degree of sustainability. LEED is an ecology-oriented building certification program run under the auspices of the U.S. Green Building Council (USGBC). LEED concentrates its efforts on improving performance on five key areas of environmental and human health, namely:

- i) Energy efficiency
- ii) Indoor environmental quality
- iii) Material selection
- iv) Sustainable site development and
- v) Water savings.

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Understanding the Earned Value Management system



EVMS is the primary project management tool integrating scope, schedule and cost parameters of the contract. It combines schedule performance and cost performance to answer the question "What did we get for money we spent". It is a way to measure project performance against project baseline and plan corrective measures well in advance, if required. Some professionals view EVMS as a complicated process hence do not consider applying it in their projects although its use could give them a competitive advantage. As a matter of fact, aside from acronyms the technique is not complicated and once adopted offers quite tangible benefits. The aim of this paper is to introduce EVMS in a simpler

Background

In late sixties, United State's Department of Defense developed 35 criteria referred to as the Cost/Schedule Control System Criteria (C/SCSC).

These criteria were then consistently applied to all contracts for next three decades as a method of early warning to project management team for identifying and controlling problems before they became formidable.

In 1996 C/SCSC criteria were rewritten under the new title "Earned Value

Management System" (EVMS) reducing the criteria to 32 number. In June 1998, National Defense Industrial Association (NDIA) obtained the acceptance of EVMS as an American National Standard, namely ANSI/EIA-748 standards.

The basic concepts in applying the EVMS are as follows:

- All project steps "earn" value as work is progressed/completed.
- Physical progress is measured in money e.g. dollars so that schedule performance and cost

performance can be analyzed in the same terms.

- The earned value can then be compared to actual costs and planned costs to determine project performance and predict future performance trends.

Terminology

The scope of this article is limited to facilitate the reader in understanding, knowhow and motivating for beneficial use of the technique without going into complexities of the ANSI standard's compliance requirements. Table 1 describes the various terminology used.

EVMS Applications

The industry standard for project control systems described in ANSI/EIA-748 states that EVMS must be implemented on all projects with total cost greater than \$20 million for control of project performance during the execution phase [1].

Although the ANSI standard requires full application of all 32 criteria in its 5 categories whenever the project risks and complexities warrant it, however, experience has dictated that most of the projects could be equally benefitted by following ten fundamental principles. These principles or minimum requirements necessary to implement a "simple" form of EVM on any project are stated below [2].

Define Project Scope

Project scope must define in full extent the authorized work elements including objectives and deliverables. This needs to be done for any project for simple reason to know the project status at all times and when it is done. Detailed scope is particularly critical on projects where one intends to measure earned value performance. Work Breakdown Structure (WBS) is the most useful tool available for defining a new job. WBS is then decomposed to further measureable work packages. Once WBS is finalized, the same can be used for further critical steps of planning, scheduling, estimating, budgeting, and the like.

Define Project Organization Structure

Determine who will perform the defined works including all critical procurement and identifying project organization structure, subcontractor's works and in-house works etc.

Planning and Scheduling

Backbone of earned value technique is a good scheduling system with authorized resources/budget embedded into the schedule. It reflects the base line "planned values" for everyone to follow. Once prepared and approved it is called Performance Measurement Base Line (PMBL) and cannot be changed without instruction from authorities to incorporate the approved changes.

Understanding the Earned Value Management system

Term	Acronym	Description
Planned Value	PV	PV is the budget assigned to scheduled work or work breakdown structure element.
Earned Value	EV	EV is the value of the completed work in terms of approved budget assigned to that scheduled work or work breakdown structure element.
Actual Cost	AC	AC is the total cost incurred in accomplishing the scheduled work or work breakdown structure element.
Budget at Completion	BAC	BAC is the total amount of funds to be spent at completion of project
Estimate at Completion	EAC	EAC is the estimate of total cost of project based on actual cost to date.
Estimate to Complete	ETC	ETC is expected cost needed to complete all remaining works of the project
Variance at Completion	VAC	VAC is the difference between the BAC and expected total costs to be accrued at project based on current trends.

Table 1. Terminology Commonly Used in EVMS

Estimate Resources and Authorize Budgets

Having prepared the schedule, which describe the project scope, sequence of works with its interdependencies, the next step is to estimate budget for all defined tasks with identification of significant cost elements i.e. labor, materials, etc., as needed for in-house works and for the control of subcontractors. Each defined WBS element must have resource value estimated to complete all specified works but should not contain any contingencies or management reserves.

Determine Metrics for Progress Measurement

Specific milestones or tasks with weighted values are measured as they are physically performed. Measurable and verifiable metrics are set up in the baseline schedule to quantify the authorized work and then to measure its completion. Out of few available methods of performance measurement, some are described below:

a. **Weighted Milestones:** each milestone is given a budget value that will be earned on completion of event. Thus total work package is divided up based on weighted value assigned to each milestone. This is a preferred method for performance measurement but require detailed milestone planning to establish meaningful milestone. This is used for long term duration and ideally should have milestone for each month or accounting period. This can be used for payment scheme too.

b. **Milestone weighted with percentage complete:** This allow earning a portion of the value of the milestone equal to amount of work completed for activity(s) that make up the milestone. This method like "a" above require objective measurable milestone allowing partial credit against milestone, but it require cost account manager assessment of the percent complete for each milestone and require documentation of assessed method.

c. **Fixed Formula:** This method applies a fixed percentage of completion upon the start and finish of an activity. Usual percentages used in formula are 0/100, 50/50, 33/67, etc. First part shows the credit earned upon start and second when activity is completed.

d. **Percent Complete:** This is the easiest method but subject to the individual's bias and optimistic figures often provided by the individual in charge of work package. Customer satisfaction may be low due to the subjectivity involved and the lack of detailed planning.

Prepare Performance Measure Baseline and Determine Points of Management Control or Cost Control

Earned value technique requires use of integrated project base line i.e. defined works including both baseline schedule and authorized budget. This integration is within each of WBS element. Sum of these cost accounts constitutes total project baseline, thus EV performance measurement will take place within each of the specified control account.

Record all Costs

Direct and indirect costs are recorded with the authorized baseline budget in accordance with the organization's general books of account. This simply requires that project management be informed as to how much money they have spent on the project. It is absolutely essential that cost is identified as work progresses and these actual costs are aligned to the authorized budget.

Continuously Monitor

Monitor the earned value performance at least monthly to determine cost and schedule variances from the base line and compare with defined acceptable tolerances to focus attention on such exceptions. Each behind schedule task should be assessed to its criticality if such task is on critical path or carry high risk to project then efforts must be

taken to get the late tasks back on schedule.

Future Forecast

Using earned value data, forecast the final required cost based on actual performance for management to take corrective measures, if necessary. Most beneficial aspect of EVMS is its capability to quickly forecast the total funds required to complete the project. Actual performance good or bad is in effect "sunken cost" and the improvement in performance must come from the future works/tasks of the project.

Change Management

An effective change management control system must be established to incorporate approved changes into project base line in timely manner. Performance baseline and consequently resulting EVM will be ineffective and misleading if changes i.e. addition or deletion of added work scope is not dealt with in time.

Earned Value Analysis (EVA) for Project Tracking and Forecasting

EVA is a way to measure amount of work actually performed on a project and to forecast its cost and date of completion. EVA uses three data values which are computed each reporting/ analysis period, generally monthly. The three key data components are PV, EV and AC.

PV= Total budget cost up to analysis date thus answering the question, "What do you plan to do?"

EV= Quantification of the "worth" to date thus answering the question, "What are physical accomplishment up to the analysis date?"

AC= Actual cost incurred for executing the works as of this date thus answering the question, "What actually have you spent ? Project tracking is computation of four measures from the above basic data: Schedule Variance (SV), Cost Variance (CV), Schedule Performance Index (SPI) and Cost Performance Index (CPI). Table 2 describes the various formulas for calculating different parameters in EVA.

Analysis report should include data, variances, indices and forecasts etc in numerical format showing values and in graphical format showing trends [3-4]. Any schedule variance on critical path and/or near critical path should be identified and its impact on subsequent milestones and the project cost and schedule quantified in order to address such tasks more aggressively in bringing these back on schedule.

The analysis should preferably include cause(s) of variances and corrective actions taken or recommended in reaction to the variance. Graphical format presentation of EVA is presented in Figure 1 and these can be implemented as dash board layout for executive management. The graph are prepared for clarity and and figures shown are hypotheticalal.

Understanding the Earned Value Management System

Limitations of EVMS

EVMS in general the following limitations:

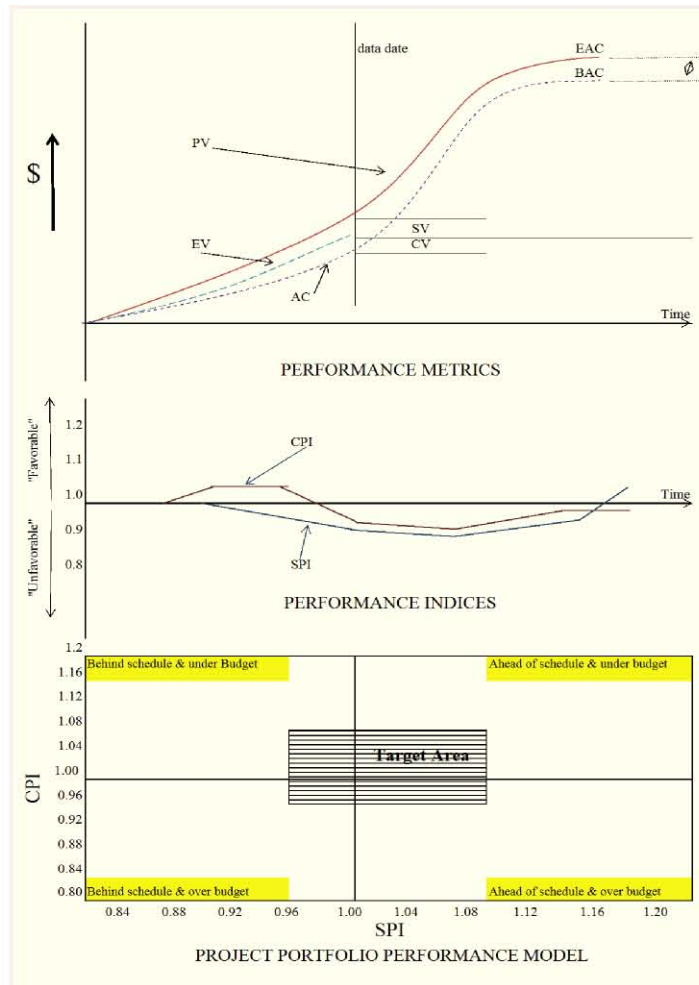
- It neither addresses critical path nor the impact of work sequence, thus driving site management to work on wrong tasks in order to earn "value".
- The delayed recording of actual costs of materials, subcontractors etc may lead to EVA results not comparable especially if there is significant difference between project reporting time and financial accounting times.
- EVMS has no provision to measure project quality, it is possible that EVMS indicates project under budget, ahead of schedule, and scope fully executed, however, still may result in an unhappy client and ultimately unsuccessful effort.
- EVMS assumes stakeholders care about measuring progress objectively. EVMS is unlikely to help if done to fulfill the customer requirements.

Conclusions

EVMS indices combined with baseline schedule tells us where we are and where we are heading. It provides us assessment of our project status as of analysis date thus allowing to steer a better course towards our project objectives. We can decide where we want to go after knowing where we are. It enables spotting a potential problem early in the project and provides basis for course correction and bring back the project on schedule and cost as the manager can plan risk mitigation measures with clearer picture. It helps answer the question like "Is there enough money left in the budget?", "Will we finish on time?" It has limitations too, for example, it does not delve into the project quality nor does focus customer requirements.

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Term	Acronym	Formula	Remarks
Cost Variance	CV	$CV=EV-AC$	+ value is good
Schedule Variance	SV	$SV=EV-PV$	+ value is good
Schedule Performance Index	SPI	$SPI=EV/PV$	SPI=1, Right on schedule SPI>1, Ahead of schedule SPI<1, Behind schedule
Cost Performance Index	CPI	$CPI=EV/AC$	CPI=1, On Budget CPI>1, Under Budget CPI<1, Over Budget
Estimate at Completion	EAC	$EAC=BAC/CPI$ $EAC=AC+ETC$ $EAC=AC+(BAC-EV)$	Based upon actual performance to date.
Estimate to Complete	ETC	$ETC=BAC-EV$ $ETC=BAC-EV / CPI$	Proj.team expects similar variation will not occur in future. If current variations are seen as typical of future variance.
Variance at Completion	VAC	$VAC=BAC-EAC$	VAC forecast difference between BAC and expected total cost to be accrued for project based on current trend.
To Complete Performance Index	TCPI	$TCPI=(BAC-EV) / (BAC-AC)$	Remaining works divided by remaining money left. TCPI tells how much of an increase in performance is needed on remaining works in order to keep within budget.
Schedule at Completion or Estimated time at Completion	SAC	Planned project duration/SPI	Estimated time of completing the project calculated by dividing the project's planned schedule (duration) by SPI.
Cost Schedule Index	CSI	$CSI=CPI \times SPI$	CSI measure the likelihood of recovery for project that is late and/or over budget. The closer the index to 1, the more likely the project can be recovered.

Table 2. Formulas Used in EVA.

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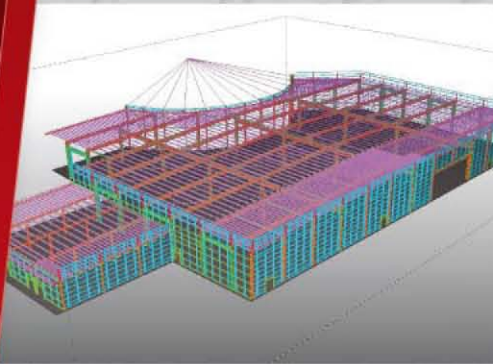
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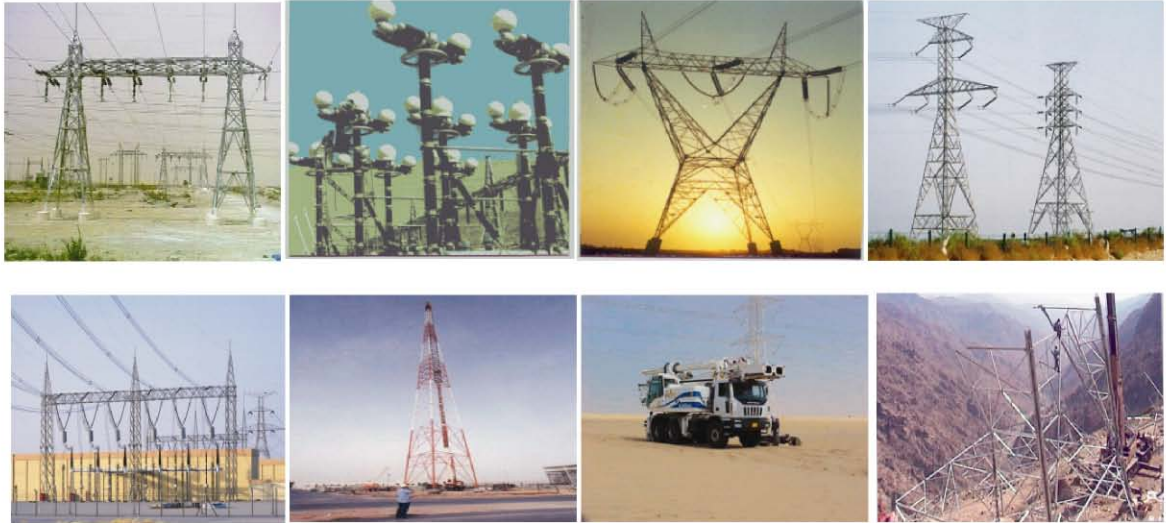
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Off-Circuit and On-Load Tap Changers For **TRANSFORMERS**

Tap changer is an essential element of every transformer, be it a power transformer or a distribution transformer. It is used for changing the tapping connection of the transformer winding while it is de-energized or on-load. This paper discusses in detail the basic function, connection circuits, design concepts, construction and main parts of off-circuit and on-load tap changers used in distribution and power transformers. Various types of on-load tap changers and motor drive units are discussed. The significance of preventive and condition-based maintenance philosophy is highlighted. Annual maintenance and major inspection activities are also discussed.



Voltage Regulation

Voltage variation in electrical systems is a normal phenomenon because power demand changes constantly. It is essential to maintain the system voltage within the specified limits and power utilities are under obligation to their customers to maintain the supply voltage between such limits. By changing the turn ratio of transformer, the voltage ratio and secondary voltage is changed and voltage regulation is achieved. The device used for adding or subtracting the turns of primary or secondary winding of transformer is called a tap changer. The output voltage of transformer can be kept constant by adding or subtracting number of turns in the primary or secondary winding depending upon location of the tap changer. At lower voltages, the tap changer may be located at either the low voltage or high voltage winding, however, at medium, high and extra high voltage levels, tap changers are installed on high voltage winding. Tap changers can be divided into two categories; off-circuit and on-load. The off-circuit tap changers are installed on the distribution as well as power transformers. On the distribution transformers, they are used for control of seasonal voltage variations and operate only when the transformer is de-energized. The on-load tap changers are installed on power transformers and used for control of daily voltage variations due to changing load, short period voltage variations, and the reactive and active power variations. Without On-Load Tap Changer (OLTC) transformers, these parameters can only be controlled at the generating plant or by supply interruptions and de-energized tap changing. OLTC offers variable control to keep the supply voltage within the specified limits generally $\pm 10\%$. The introduction of OLTC improved the operating efficiency of electrical systems considerably.

The Off-Circuit Tap Changer

The most economical method of changing the turn ratio of a transformer is the use of Off-Circuit Tap Changer (OCTC), also known as De-energized Tap Changer (DTC) as the transformation ratio can be adjusted only when transformer is de-energized. Usually the turn ratio of the high voltage (HV) winding is regulated to $\pm 2.5\%$ or $\pm 5\%$ to suit the local condition. The distribution transformers are normally equipped with 5 or 7 positions OCTC. Position 1 of the tap-changer (+ position) corresponds to the highest ratio, which gives the lowest voltage on the low voltage (LV) side. Position 5 or 7 of the tap-changer (- position) corresponds to the lowest ratio, which consequently gives the highest voltage on the LV side. The control shaft of the OCTC is brought through the cover or the tank wall. The shaft end is provided with a handle, position indicator and locking device. When the tap position is changed,

the locking device must be secured to ensure that the OCTC has been set to the desired operating position. The OCTC shall be turned from one extreme position to another for contact wipe approximately at least once a year. This is necessary when the tap changer is used infrequently. For dry-type transformers, the de-energized tap changing is generally done by means of bolted links.

An off-circuit tap changer consists principally of three parts; operating handle projecting outside the transformer, fixed contact with connecting terminals and insulating shaft with moving contact as shown in Figure 1.

The basic transformer winding circuit arrangements using OCTC are shown in Figure 2.

They are; linear, single-bridging, double-bridging, series-parallel and star-delta. Depending upon the requirement, any one arrangement of the winding can be used to get desired voltage regulation.

The On-load Tap Changer

The on-load tap changer is a device for changing the tapping connection of a winding while the transformer is on load. On-load regulation allows continuous adjustment of the transformer ratio. When a transformer's load increases, the system impedance causes the voltage to drop. When the load decreases, the voltage rises. The OLTC senses the change in voltage and adjusts regulating winding to keep the voltage within the acceptable limits. The passage from one tap to another without interrupting the principal circuit requires two taps to be connected together for a very short period. To avoid a complete short circuit, this connection is made through a resistance or less commonly through an inductance. On-load regulation is required for each phase, therefore, one or more windings for regulation, a tap selector, a

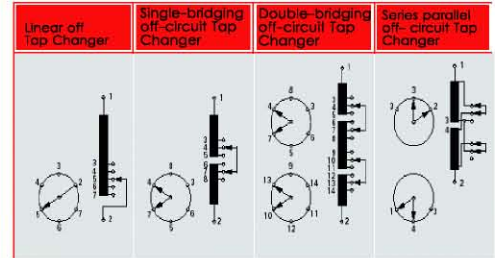


Figure 2. Off-circuit tap changer connection circuits

resistor and some switches are needed to enable the change to be made. The OLTC contacts are connected to the taps of a regulating winding. About 96% of all power transformers today above 10MVA incorporate on-load tap changers as a means of voltage regulation. OLTCs are used in applications where variable voltage is required for manufacturing processes.

Design Concepts of OLTC

To effect the change in turn ratio of a transformer under load, two design concepts are used.

- The OLTC comprising either of a tap selector with or without reversing switch or coarse tap selector switch and a diverter switch, known as diverter switch type.
- The OLTC having a selector switch combining the function of tap selector and diverter switch in one device, known as selector type.

Principle Circuits of OLTC Transformers

The tapped portion of the winding may be located at one of the following locations, depending upon the type of winding:

- At the line end of the winding
- In the middle of the winding
- At the star point.

For two-winding power transformers, the most popular arrangement is the regulation at the neutral end of the winding. This solution provides the most economical tap winding arrangement with generally graded insulation combined with a compact three-phase neutral point OLTC.

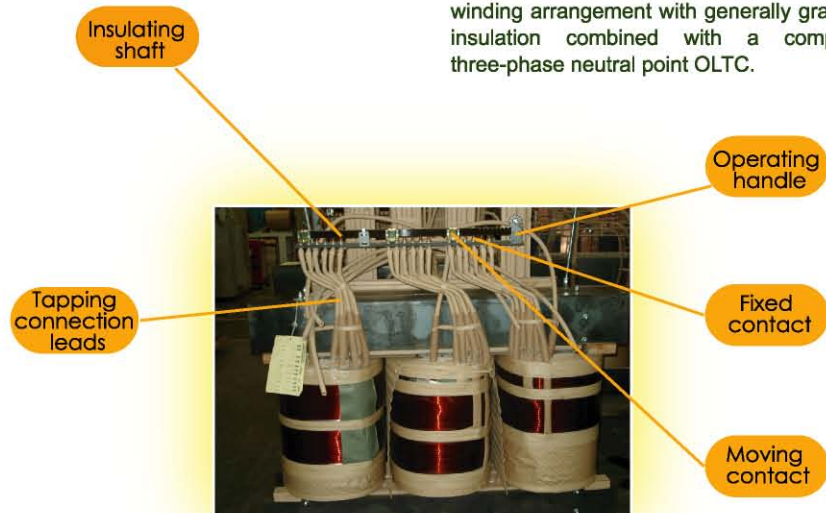


Figure 1. An Off-circuit tap changer (5-position) installed on a 1600kVA, 13.8kV/400V, Dyn11 distribution transformer

TRANSFORMERS

Constructional Features of OLTC

The main parts of an on-load tap-changer are; diverter Switch, tap Selector and motor drive unit. The reversing or course-fine switch is part of tap selector. The motor drive, diverter and tap selector operate as a unit to effect transfer current from one voltage tap to the next. Most substation type regulating transformers have a 10% tap winding. The polarity of the tap winding can be reversed under load. This gives the transformer the ability to lower or raise the voltage ratio by 10% above or below its nominal voltage rating. Tap changers possess two fundamental features; some form of impedance is present to prevent short circuiting of the tapped section, and a duplicate circuit is provided so that one circuit can carry the load current while switching is being carried out on the other. The impedance can either be a resistor or a center-tapped reactor. Transition resistor type tap changers which carry out selection and switching on the same contacts are single compartment design and those which have tap selectors and separate diverter switch are double compartment design.

Single Compartment Design

In the single compartment design, same contacts are employed for selection and transfer of current. All the contacts are housed in the same compartment. The insulating oil of this compartment is kept isolated from the main transformer oil. Figure 4 shows electrical principle for selector type OLTC.

Figure 4. Electrical principle for the selector type on-load tap changer (diverter/selector combination)

Double Compartment Design

Large transformers of high voltage class employ double compartment type OLTCs. A compartment houses make-break contacts and transition resistors and another compartment houses the tap selector. The electrical principle for the diverter type

The switching arrangements may be linear, reversing or coarse-fine. Figure 3 shows typical switching arrangements. The linear switching is not very common; it is used in around 20% cases. The design of transformer and OLTC is simple, regulating range is smallest and losses are smallest. The reversing (plus/minus) switching is most common, used in around 70% cases. The tap winding is either additive (+) or subtractive (-) depending upon position of reversing switch and it has change over selector. The coarse/fine switching is least common switching arrangement used in around 10% cases. The coarse winding is inserted in the main winding, having change over selector and also losses are small.

OLTC is shown in Figure 5.

As the tap selector is housed in the same tank along with transformer, the transformer buchholz relay takes care of tap selector also. However, for diverter switch a separate oil surge relay is provided because the oil in diverter switch compartment is not in contact with the transformer tank oil. The oil surge relay trips the transformer for any electrical fault that takes place in the diverter switch compartment.

The Resistor Type OLTC

The Resistor type OLTC may consist of diverter switch or diverter/selector combined switch, oil compartment, tap selector, change-over Selector, tie-in resistor, drive mechanism, conservator tank and accessories. The major components of OLTC are further discussed below.

Diverter Switch

A diverter switch is a major OLTC component. It is used to transfer the load from the selected to the pre-selected tap without interruption of the transformer load current. Diverter switches are installed in the tap changer oil compartment, which separates the tap-changer oil from the oil of the transformer main tank.

Spark Gaps

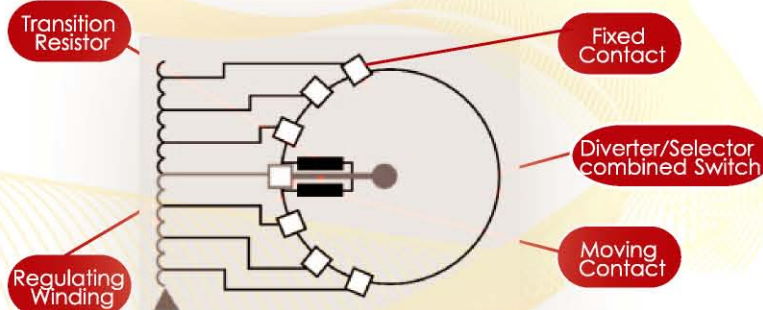
Spark gaps are a standard protective device against surges between selected and pre-selected tap for diverter switches. The spark gaps are arranged at the diverter switch contact shell. In some tap changer applications varistors are used instead of spark gaps.

Varistors

Varistors are non-linear resistors like the ones that are used in surge arresters. Varistors can be used to limit surges between selected and pre-selected tap inside the tap changer compartment.

Tap Selector

The purpose of a tap selector is to transfer connection from a common terminal to a multiplicity of leads connected to the tap winding of a transformer. Tap selector contacts do not switch currents but are always operated under no-load conditions. Tap selectors are usually arranged beneath the tap-changer oil compartment and are immersed in the insulating oil of the transformer main tank.



Transition Resistors

In the mid-position of a tap change operation, both the selected tap as well as the pre-selected tap are connected with the output terminal of the tap changer. In order to avoid a short circuit between these two taps, a transition resistor is necessary for limitation of the circulating current.

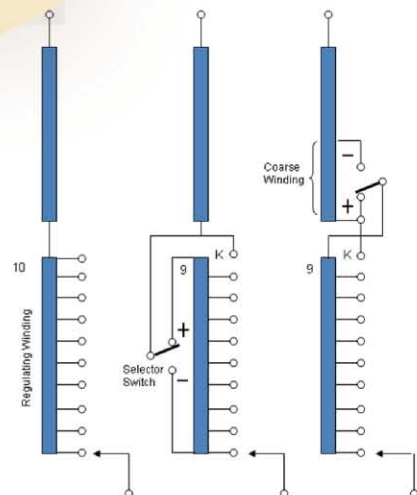


Figure 3. Linear, Reversing switch and Coarse-fine Switch tysswitch-type connection diagrams.

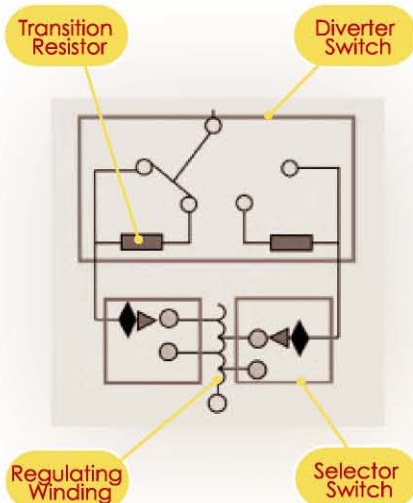


Figure 5. Electrical principle for the diverter type on-load tap changer

Change-over Selector

A tap changer with changeover selector allows the tap selector to move through a second revolution and thus increases the tapping range. It can be used either as reversing switch for the buck-and-boost connection or as coarse tap selector to connect the beginning or end of a coarse tap winding to the main winding. In any case the resulting range will be doubled.

Tie-in Resistor

The tap winding is briefly galvanically isolated from the main winding during the change-over operation of the reversing switch or coarse tap selector. It assumes a potential resulting from the voltages of the adjacent windings and coupling capacitances to these windings or to grounded parts. This potential shift of the tap winding generates corresponding voltages between the breaking change-over selector contacts as one contact is always connected with the tap winding and the other contact is always connected with the main winding. This voltage is called recovery voltage. When the change-over selector contacts open, a capacitive current is interrupted, called breaking current. The recovery voltage and braking current may cause excessive discharges on the change-over selector and damage the transformer. Therefore, tie-in resistor shall be used when recovery voltage exceed maximum permissible value given by the tap changer manufacturer.

Motor Drive Unit

The motor drive unit is used for operating on-load and off-circuit tap changers in regulating transformers. The tap change operation can be activated by starting the motor drive from local or remote raise/lower push buttons or a control pulse triggered by voltage regulator relay. The tap change operation is always completed regardless of any other control pulses emitted during the operating time.

OLTC Conservator Tank

An oil filled tank, mounted above the OLTC and piped into it is usually filled half way and is used to keep the level of the oil in the diverter switch compartment always full. The conservator tanks are available in two designs, without and with bellows. The former has the advantage that there is no direct contact of oil with air thereby prevents oxidation and moisture contents in oil.

Accessories

The accessories for on-load tap changer are; OLTC protective relay, pressure relief device, oil level indicator, dehydrating breather, oil filter plant, OLTC on-line monitor and their application depends on individual requirement.

Vacuum Switching OLTC

The vacuum switching technology is used in reactor-type tap changers. This has revolutionized resistor-type tap-changers. The advantages of vacuum switching are service requirements after 150,000 to 500,000 switching operations which drastically reduce running costs for the whole life and increases availability of the transformer. Also, there is no oil carbonization; no replacement of contacts and no oil filter systems required.

Thyristor-assisted Tap Changer

Thyristor-assisted tap changer uses thyristors to take the on-load current while the main contacts change over from one tap to the next. This prevents arcing on the main contacts and can lead to a longer service life between maintenance activities. They are more complex and require a low voltage power supply for the thyristor circuitry. They also can be more costly.

Solid state (Thyristor) Tap Changer

They use thyristors to switch the load current as well as to pass the load current in the steady state. Their disadvantage is that all of the non-conducting thyristors connected to the unselected taps still dissipate power due to their leakage current and they have smaller short circuit withstand capacity. This power can add up to a few kilowatts which has to be removed as heat and leads to a reduction in the overall efficiency of the transformer, in exchange for a compact design that reduces the size and weight of the tap changer device. Solid state tap changers are typically employed only on smaller power transformers.

Maintenance of Tap Changers

Malfunctions in tap changers may result in spectacular and costly failures. An international survey on failures in large power transformers showed that tap changers were the source of some 40% of transformer faults. Maintenance strategies such as time-based or Preventive Maintenance (PM) and

predictive or Condition-Based Maintenance (CBM) could be adopted in order to keep the operational reliability of tap changer and transformer on a high level. Tap changer PM activities include periodic checks, annual inspection and major overhauls. The CBM tests are: on-line Dissolved Gas in oil Analysis (DGA) of diverter switch compartment, acoustic emission and vibration technique

Annual Maintenance

The annual maintenance activities of on-load tap changer include the following:

1. Visual checks of OLTC head, protective relay and motor drive unit.
2. Visual checks for oil tightness at the sealing locations of the OLTC head, the protective relay and the pipe connections.
3. Visual checks of the gaskets at the protective housing of the motor drive unit.
4. Check for proper function of the electric heater in the protective housing of the motor drive unit.
5. Check of state of the drying medium (silica gel) and the oil level in the dehydrating breather.
6. Operational checks.
7. Inspection of position switches.
8. Check of upper and lower electrical limits, mechanical stops, safety switch and bevel gears.
9. Operation of tap changer from end to end positions 5 times. It is necessary for contact wipe.
10. General inspection and completion of inspection sheets.

Major Inspection

Depending on the type, the first inspection may be after two years and then four to seven years thereafter. In countries with tropical and subtropical climate, the humidity should be taken into account. Maintenance work may be started only if the relative humidity is less than 75%. The major inspection activities of OLTC include the following:

1. Perform ratio test at minimum, mid, mid-1, mid+1 and maximum tap positions e.g. if there are 27 tap positions then tap positions will be 1, 13, 14, 15 and 27.
2. Drain oil from diverter switch compartment.
3. Dismantle and remove diverter switch for inspection and clean diverter housing.
4. Inspect and/or change contacts (wear dependent).
5. Confirm integrity of transition resistors (ohmmeter).
6. Re-install diverter switch and fill the insulating oil.
7. Confirm dielectric strength of oil and filter (OILTAP).
8. Vacuum check of vacuum interrupters (VACUTAP).
9. Review and lubricate motor drive.
10. Check tap position indicators in motor drive and tap changer head to indicate the

TRANSFORMERS

same position.

11. Perform ratio test to ensure that driving mechanism and tap changer are in their proper position.
12. Perform functional test of the protective relay and de-air it.
13. Check manual cranking balancing.
14. Check rotation lag balancing.
15. Complete inspection check-sheets.

Contact Replacement

Contact life estimate is stated in equipment manual or on name plate. Average power transformer experiences approximately 20 tap changing operations a day which equates to 219,000 operations over 30 years. Since contacts have a long life expectancy, contact replacement will most likely not be necessary over useful life of transformer.

Tap Selector Inspections

Tap selector should be inspected after 1 to 1.5 million operations, depending on the type of tap changer and on the selector design.

9 Summary

Tap changers are one of the indispensable components for the regulation of power transformers used in electrical energy networks and industrial applications. Taps are used in the winding to change the turn ratio of transformer and maintain output voltage. An off-circuit tap changer allows the voltage ratio of the transformer

to be adjusted while it is de-energized and an on-load tap changer changes the turn ratio of the transformer winding while it is energized. The OLTC active component construction can be either of the diverter or selector type switching principle. There are three basic tapping arrangements; linear, reversing switch or coarse-fine switch and each have their own advantages and disadvantages depending upon the application. The OLTCs are

classified as oil type, vacuum type and electronic/thyristor type. Switching from one position to another has to be performed through impedance; either a resistor or a reactor to avoid a short circuit between two steps of the regulating winding. The resistor type OLTCs may be single compartment design or double compartment design. The main components of an OLTC are

contact systems for make-and-break currents as well as carrying currents, transition impedances, gearings, spring energy accumulators, and a drive mechanism. In new OLTC designs, the contacts for make-and-break currents are replaced by vacuum interrupters. Since the year 2000, high speed resistor type OLTC are commercially available for in-tank installation on oil filled transformers. As tap changers are major source of transformer failures, maintenance strategies have been described for the regulating transformer's high level of reliability.



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PAKISTANI UNIVERSITIES STATISTICS

REGION	UNIVERSITIES	PUBLIC	PRIVATE
AJK	3	1	2
Balochistan	6	5	1
Islamabad	17	14	3
Northern Areas	1	1	
NWFP	21	12	9
Punjab	36	19	17
Sindh	38	13	25
Total	122	65	57



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Duplex Stainless Steels

And Their Applications In Desalination Industry



Duplex stainless steels are among various metals used in corrosion-resistant applications. This article presents an overview of the its properties, advantages, and disadvantages and compares with other materials suitable for corrosion-prone environments. It also discusses duplex stainless steel applications in desalination industry.

INTRODUCTION

The word duplex is based on the concept of austenite and ferrite formulated in the same material. Duplex Stainless steels are defined as stainless steels with a microstructure comprising typically 40-50% ferrite and rest of that austenite. The Duplex Stainless steels combine important properties from both ferritic and austenitic stainless steels. They show good stress corrosion resistance and also good ductility and weldability. All modern duplex stainless steels have low carbon content. Duplex grades with PRE number (PRE=Pitting Resistance Equivalent

$\%Cr + 3.3\%Mo + 16\%N$) greater than 40 are called "Super Duplex Stainless Steels." These steels possess very good corrosion-resistant properties, especially in chloride containing environments. The Duplex steel is cost-effective in more than one way. It costs less than many other materials used in corrosive atmospheres. Its yield strength is double that of the 300 series stainless steel thus allowing the use of a thinner material to support a similar load.

The cost of fabricating duplex usually is lower than that of other materials because of its comparative ease of machining and welding. The ferrite content of duplex causes its welding to be less intimidating than when welding high-nickel alloys. This factor alone saves significant weld time. Furthermore, high-nickel alloys are welded with small stringer beads and low heat input whereas duplex requires higher heat input and a slight weave bead.

Duplex's machining rate of travel is similar to that of 316 stainless steel with high-speed steel tooling, and it requires fewer machining labor-hours than high-nickel alloys. Welding wire and gas costs are less with duplex, except when the corrosive atmosphere is extreme. Forming duplex is not complicated. The material can be bent and rolled by almost the same methods as 50,000-PSI-yield-strength material. Conventional rolls and dies are sufficient for forming most shapes, which eliminates the added cost of purchasing special rolls and dies. The only significant requirement is that the dies and rolls must have a hardness of at least 34 Rockwell C to prevent carbon impregnation.

Historical Development

Stainless Steels were developed in the first decade of this century in Britain and Germany. The earliest stainless steels were martensitic and ferritic iron-chromium steels but quite soon austenitic iron-chromium-nickel steels became the largest group. In 1930, Avesta Iron works developed two ferritic-austenitic stainless steels namely Grade 453E and Grade 453S (UNS S32900) [1]. The duplex microstructure resulted in a much higher strength than for the austenitic stainless steels. They also had good castability. Due to the comparatively high chromium content the duplex steels had much improved scaling

resistance. The J. Holtzer Steel Works in France were granted a patent in 1936 of ferritic-austenitic alloy containing 16-23% chromium, 1.5-6.5% nickel, up to 3% molybdenum, 3% tungsten and 2.5% copper [2]. From this patent, Uranus 50 (UNS S32404), one of the pioneer duplex alloys was developed by Creusot Loire Industrie. One of the first duplex stainless steels with low carbon content and designed for Stress Cracking Corrosion (SSC) resistance, was 3RE60 (UNS S31500) developed in 1940 by Sandvik Steel. The development of a 22% chromium duplex stainless steel (S 31803) was focused to improve the inter-granular corrosion and proved to have much higher mechanical strength and better corrosion than 316L and 317L and sometimes even N08904. This duplex steel provided low cost alternative for many applications and was produced worldwide. In

1980, super duplex stainless steels (S 32750 and S 32760) were produced. The high alloy content resulted in both superior corrosion resistance and mechanical strength and provided a competitive alternative to the super austenitic stainless steels such as the 6% Mo steels.

Most Common Duplex Stainless Steels

Several duplex stainless steels are used in the process industry. However, the most common ones are SAF 2205, SAF 2304, and SAF 2507. Their nominal compositions along with UNS designation and PRE No. have been listed in Table 1 [3]. For comparison, two most popular grades of standard stainless steels (304 and 316L) are also included. Presently, large amount of SAF, 2205, 2304, and SAF 2507 are in service in process plants, especially in seawater applications.

SAF 2205 (UNS S 31803)

The SAF 2205 is a duplex stainless steel with chemical composition balanced in such a manner that reformation of austenite in the heat-affected zone adjacent to weld takes place quickly. This will give welded joints good mechanical and corrosion properties. Due to its corrosion properties, SAF 2205 is used in environments containing chlorides and hydrogen sulphide, like tubing and flow lines for the extraction of oil and gas from sour wells and process solutions containing chlorides. It is also suitable in heat

exchangers where chloride-bearing water is used as cooling medium. The alloy shows good resistance to general corrosion and, especially in acid containing halides, the steel is much superior to conventional stainless steels. The SAF 2205 is available as plate, sheet, strip, welded or seamless tube and pipe, pipe fittings, flanges, bars, castings and welding consumable.

SAF 2304 (UNS S32304)

The SAF 2304 is low alloy duplex stainless steel. It possesses good corrosion resistance in acidic environments and has a pitting resistance comparable to that of 316. It has very good resistance to stress corrosion cracking in chloride-bearing environments, much better than 316L. SAF 2304 is also characterized by good resistance to general corrosion and pitting.



Alloy	Trade mark	UNS	C max.	Cr	Ni	Mo	N	PREN
304		S 30400	0.08		9			18
316L		S 31603	0.03	17	12	2		24
SAF 2304	Avesta Sheffield AB Sandvik Steel	S 32304	0.03	23	4.5	0.3	0.1	
SAF 2205	Avesta Sheffield	S31803	0.03	22	5.5	3.0	0.17	
SAF2507	Avesta Sheffield	S32750	0.03	25	7	4.0	0.28	42.5
	Avesta Sheffield	S32760	0.03	25	7	3.7	0.25	
AF22	Mannesmann	(1.4462)	0.023	22.4	5.6	3.1	0.2	
ZERON 100	WMS	S31260		25	7	3.5	0.25	42
Ferrialium 255	Bonar Langley	-	0.02	25.5	5.54	3.47	0.17	
DP-3 (SM25CR)	Sumitomo	S31260	0.014	24.95	6.8	3.18	0.14	38
DP-3W (SM25CRW)	Sumitomo	S39274		25	7	3	0.27	42.5

Table 1. Compositions of Duplex Stainless Steels and standard grade stainless steels

SAF 2507 (UNS S32750)

The SAF 2507 is a high alloy super duplex stainless steel. This steel grade is a so called super duplex grade, that is a steel with a PRE number greater than 40. The ferrite content is generally between 35 and 50%. This steel is much more resistant at higher temperature in seawater cooling exchangers.

Corrosion Resistance

Corrosion resistance depends mostly on the composition of the stainless steel. For chloride pitting and crevice corrosion resistance, their chromium, molybdenum and nitrogen content are most important. Duplex stainless steels offer corrosion resistance to many different types of environments, and the resistance to localized attack is in many cases of crucial importance. The resistance of duplex grades S32304 to localized attack is not inferior to that of 316L and a duplex grade S31803 can be expected to perform slightly better than 317L. Four main corrosion types, namely, uniform corrosion, pitting, galvanic corrosion and stress corrosion cracking are discussed below:

Uniform Corrosion

The duplex stainless (Ferrallium 255) have showed superior resistance to both the austenitic and ferritic stainless steels. Alloy types 316, 18-2 and 26-1 have higher uniform corrosion rates of 6 to 20 times more than the duplex stainless.

Localized Corrosion in Seawater

Experiments conducted by Hayes International, the US Navy, and Climax Molybdenum Research Laboratory show that Duplex stainless (Ferrallium 255) has superior localized corrosion resistance when compared to standard austenitic stainless steels. Since one of the major factors in determining alloy suitability is the resistance to pitting and crevice corrosion, the alloy has been selected for many critical naval applications.

Galvanic Corrosion

Because many construction materials are used in the process industry, the galvanic corrosion characteristics must be evaluated. Duplex stainless exhibits good behavior in seawater when coupled with MONEL 400, HY 800, Al 5456, copper, type 316 stainless steels.

Stress Corrosion Cracking

Duplex stainless steels show very good Stress Corrosion Cracking (SCC) resistance, a property they have "inherited" from the ferritic side. SCC can be a problem for standard austenitic steels such as Types 304 and 316 in the presence of elevated levels of chlorides, humidity, and temperature. Conventional stainless steels such as 316L, and 317 used in such applications have been reported as failures in the

Seawater Reverse Osmosis (SWRO) Plant plants located in Saudi Arabia, Malta and Canary Island. The failures were mainly localized corrosion (pitting and crevice corrosion) and SCC. The right choice of material for such application seems to be the duplex stainless steels. It would meet the requirement of reverse osmosis process and guarantee reliable performance.

Mechanical Strength and Physical Properties

Strength

Mechanical strength of duplex stainless is generally very high. The yield strengths and the ultimate tensile strengths of these grades are considerably higher than corresponding strengths values for austenitic grades of comparable corrosion resistance. The duplex structure gives high mechanical strength approximately twice that of austenitics, combined with low thermal expansion, close to that of carbon steel. The low Ni content is cost saving and high mechanical strength means lighter constructions, which gives cost advantages.

Wear Resistance

The wear resistance of Duplex stainless steels is also better than other material of construction, like the fully austenitic (type 316L SS) or fully ferritic (type 18Cr-2Mo, E-Brite 26-1) stainless steels.

Upper Service Temperature

The upper service temperature of duplex stainless steels is around 300 °C due to the risk of embrittlement and formation of precipitates. Weldability of duplex stainless steels is good. Welding of duplex stainless steels with proper welding parameters and matching filler metals gives good corrosion and mechanical properties.

Toughness and ductility

Duplex stainless steels have significantly better toughness and ductility than ferritic grades; however, they do not reach the excellent values of austenitic grades.

Performance

There are advantages and disadvantages with all materials, as well as specific methods to overcome the disadvantages. As can be seen from below, the advantages of duplex materials make them a great addition to the ever-growing compilation of materials. Using these alloys in the power generation field has proven to be valuable for the scrubber fabrication.

Advantages

There is no such thing as an all-purpose material for corrosion resistance just as there is not just one corrosion type. Duplex alloys are in a class with several other materials for various types of

corrosion resistance. Some of the corrosive environments listed below (Table 2) depict these differences. It may be noted, however, that stainless and nickel alloys are best suited in some types of corrosive conditions.

As the table shows, some alloys outperform duplex alloys in many environments. Duplex is better than the 300 series in nearly every category. The consideration in the case of chlorides and halides must include costs.

Duplex alloys are nearly equal in strength to the C276 and AL6XN alloys. The pitting and crevice corrosion resistance of C276 and AL6XN are only slightly superior to the duplex alloys'. The corrosion rate for duplex is 23 mil/year; AL6XN is 17 mil/year (boiling NaOH, 290 °F, for 48 hours.) Duplex alloys are much more readily available than higher-nickel alloys.

The elements that provide the strength and corrosion resistance in duplex are much more common than those found in some high-nickel alloys. For instance, C276 contains tungsten. Carpenter 20Cb contains columbium and tantalum. The 625 alloy contains columbium, tantalum, cobalt, and titanium. Chromium, nickel, molybdenum, and nitrogen are common elements that provide the strength and corrosion resistance in the duplex alloys. The nitrogen is used in much the same way as it is used to protect the surface of Nitronic® 30.

Disadvantages

Welding duplex alloys is not particularly difficult, but the heat input and inter-pass temperature must be controlled to maintain the ferrite-austenite balance. Otherwise, the advantages of using the duplex material will be compromised. The time spent at 1,300 °F to 1800 °F must be controlled. The heat-affected zone (HAZ) time-at-temperature is critical in controlling the inter-metallic phases. If the matching filler wires or electrodes (ER2209 or E2209) are used to join the material, there is a slight disadvantage versus using the more expensive ERNiCrMo-3 or ENiCrMo-3 welding materials in the area of crevice corrosion. The nickel content of E2209 and ER2209 is in the range of only 7 to 9 percent, while the nickel content of ERNiCrMo-3 and ENiCrMo-3 is 56 to 58 percent. The addition of columbium and niobium limits the carbide precipitation in the HAZ. This cost is worthwhile, but it slightly diminishes the duplex's cost advantage.

Another disadvantage of Duplex Stainless Steels is in the rolling and bending process. Duplex's tensile and yield strength and the work-hardening tendency causes spring-back and sometimes re-forming. This is not

Environment	Problem	Poor	Good	Best
Chlorides	Pitting, crevice corrosion	300 Series SS	Duplex Alloys 317LXN®	Alloy 276 AL6XN®
Chlorides/Halides	Stress corrosion cracking	300 Series SS	Duplex Alloys	Alloy 600/625 AL6XN®
Hydrochloric Acid	Pitting, crevice corrosion	Titanium, Duplex, 20 Cb-3	Alloy 22, 276	Zirconium, Tantalum
Hydrofluoric Acid	Pitting, crevice corrosion	Duplex Alloys	Silver, Gold	Copper, Alloy 400
Sulfuric Acid	Pitting, crevice corrosion	Copper-Nickel (MONEL®) Alloy 601	20 Cb - 3	Alloy 622 HASTELLOY® C-22
General Acidic Attack	Critical Pitting	300 Series SS	317LNMo Duplex Alloys	Alloy 25 - 6 Mo Alloy 625

Table 2: Different stainless steels and their applications

always the case, but is common in materials thicker than 3/4 inch.

Use of Duplex Stainless Steels in Desalination Plants

The material used in the certain areas of the desalination processes such as SWRO, MSF, high pressure pumps etc. should have good uniform corrosion resistance and strength against stress corrosion cracking. However, the principal use of cast duplex steels has been in multistage high pressure water-flooded type pumps handling treated and deaerated sea water where there is likelihood of crevice corrosion. The cast duplex stainless steel used in these high pressure pumps are primarily proprietary alloys containing about 25Cr 5-6Ni 2-3Mo with N and sometimes Cu. The addition of nitrogen is particularly helpful in improving corrosion resistance. As cast they contain about 80% ferrite. Heat treatment are designed to achieve a roughly 50% ferrite composition balance.

The typical applications of Duplex Stainless Steels in RO desalination plants are:

Fujairah 171,000 m3/Day SWRO Plant, UAE

RO Seawater Supply Pump (Vert.)
Casing, Shaft, Impeller, Column Pipe, Discharge Head.
Filtered Water Pump (Horizontal)
Casing, Shaft, Impeller.
High Pressure Pump
Casing, and Impeller (IR 885).
Energy Recovery Unit (Calder)
Casing, Shaft, Impeller.
Backwash Pump (Horizontal)
Casing, Shaft, Impeller.
Backwash Waste Water Pump
(Horizontal) - Casing, Shaft, Impeller.

Shuaibah Expansion 150,000 m3/Day SWRO Plant, Saudi Arabia

RO Seawater Supply Pump
Shaft, Impeller.
Filtered Water Pump (Horizontal)
Not present.
High Pressure Pump
Casing, Shaft and Impeller.
Energy Recovery Booster Pump (ERI)
Casing, Shaft, Impeller.
Backwash Pump (Horizontal)
Casing, Shaft, Impeller.
Backwash Waste Water Pump

(Horizontal) - Casing, Shaft, Impeller.

Rabigh 168,000 m3/Day SWRO Plant, Saudi Arabia

RO Seawater Supply Pump
Not Applicable.
Filtered Water Pump (Horizontal)
Casing and Impeller (both CD4 MCU).
High Pressure Pump
Casing, and Impeller (Alloy 885).
Energy Recovery Turbine (Calder)
Casing (1.4517), Shaft and Impeller (1.4462).
Backwash Pump (Horizontal)
Casing, and Impeller (CD4MCU).
Backwash Waste Water Pump
(Horizontal)
Casing, and Impeller (CD4MCU).

Jubail 91,000 m3/Day SWRO Plant, Saudi Arabia

RO Seawater Supply Pump
Not Applicable.
High Pressure Pump
Casing, and Impeller (Alloy IDP 885).
Energy Recovery Turbine
(Reverse Pumps)
Casing, and Impeller (Alloy IDP 885).

Shuqaiq 216,000 m3/Day SWRO Plant, Saudi Arabia

RO Seawater Supply Pump – 317 L.
Filtered Water Pump (Horizontal)
Casing and Impeller (both CD4 MCU).
High Pressure Pump
Casing, and Impeller (Alloy 885).
Energy Recovery Turbine (Calder)
Casing (1.4517),
Shaft and Impeller (1.4462),
Backwash Pump (Horizontal)
Casing, and Impeller (CD4MCU).

Economic Viability

An economic analysis must not only consider the original materials costs but also the total installed first cost, which comprises material cost, fabrication cost, and installation cost. Even though the material cost of duplex stainless steel (Ferrallium 255) is higher than the type 316L stainless steel, it remains lower than some of the other alloys used in seawater service, as shown in Table

3. This fact along with the superior corrosion and erosion resistance and strength, led to the duplex alloy's many successful applications in process industry, especially the desalination industry.

Duplex stainless steels have lower nickel and molybdenum contents than their austenitic counterparts of similar corrosion resistance. Due to the lower alloying content, duplex stainless steels can be lower in cost, especially in times of high alloy surcharges. Additionally, it may often be possible to reduce the section thickness of duplex stainless steel, due to its increased yield strength compared to austenitic stainless steel. The combination can lead to significant cost and weight savings compared to a solution in austenitic stainless steels.

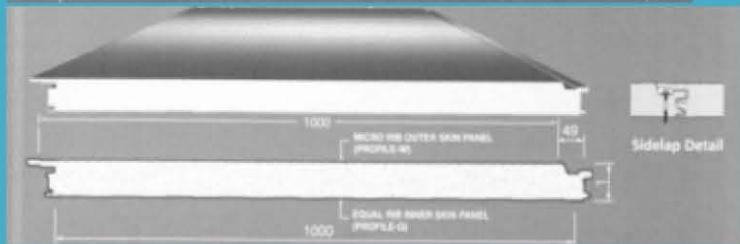
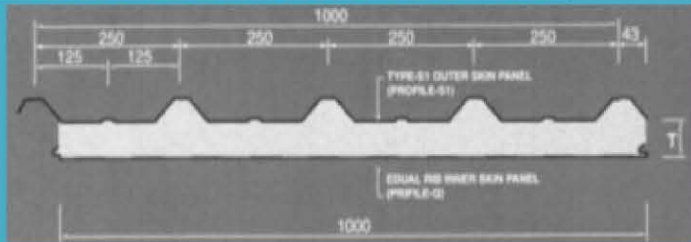


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Allah The Exalted says: And verily, you (O Muhammad) are on an exalted (standard of) character. (Al Qalam-4)

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BCOMS control rooms offer a wide variety of sizes & with an option to suit your individual specifications. If you have been considering in plant offices space for supervisors staff take a closer look at the economical and elegant BCOMS Control Rooms. BCOMS Control Rooms offer solid construction and solid value in standard & customize sizes.

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Applications:

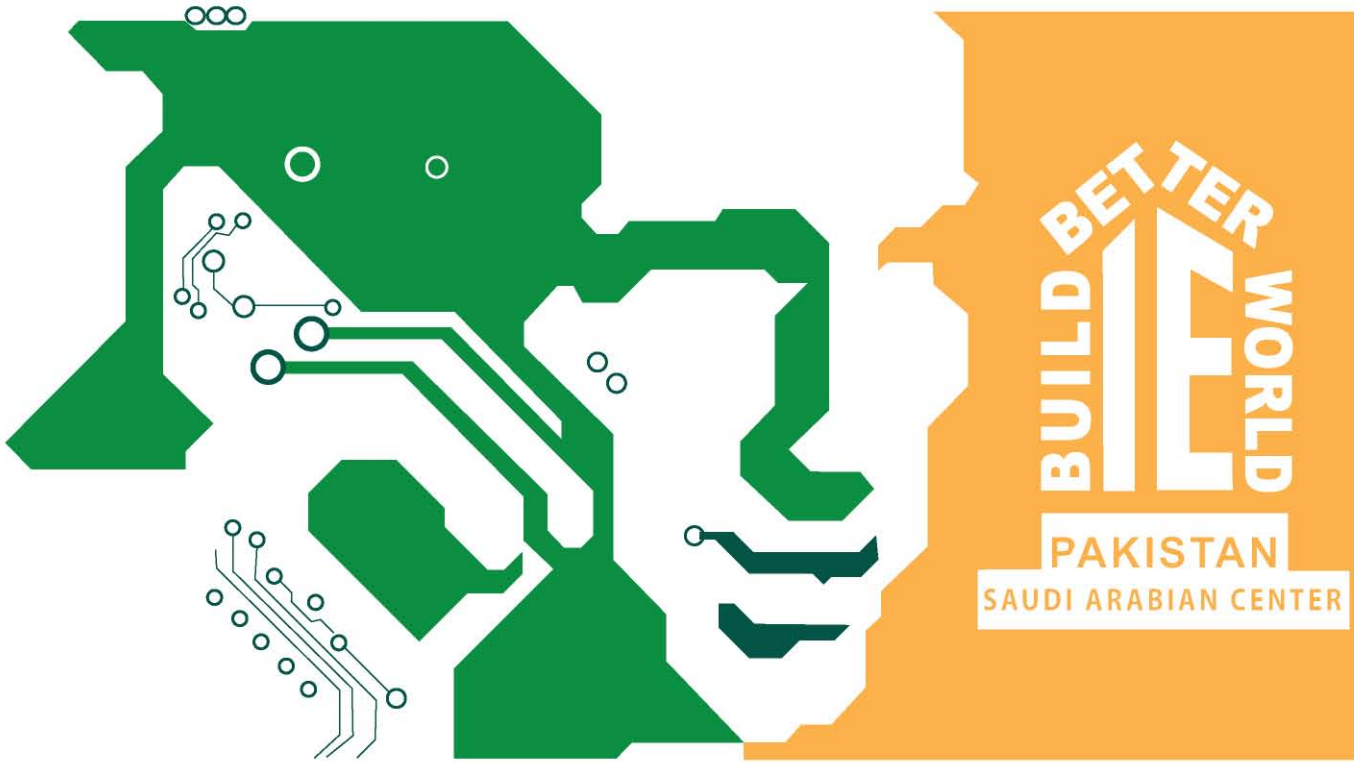
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Abu Darda (may Allah be pleased with him) narrated; he heard the Prophet (may peace and blessings of Allah be on him) saying, "The father is the middle gate of paradise, so if you like destroy this gate or guard it." (Ibn Maja-3663)

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FEATHERS An Engineering Marvel

The extraordinary gift of feathers has given birds a magic carpet which will sail virtually anywhere. This marvel of engineering design provides strong and flexible flight feathers that furnish the lift and thrust of flight whenever needed. Soon after birth, birds are presented with expensive down-lined jackets that are carefully fitted to cover their entire bodies except for their feet and legs, and part of their faces. The down in these jackets is, likewise, guaranteed to keep the body warm in cold weather and is adjustable to keep the body comfortable in warm weather. This special coat has an outer covering of contour feathers that the designer has made beautiful as well as functional. When the wind blows, it serves as an excellent windbreaker; when it rains, the jacket is water proof. The thickness and strength of this coat protects the body thermally and mechanically. Besides all this, birds are given a magic carpet which is a marvel of engineering design. The flight feathers on the wings are strong and flexible, which give birds flight whenever they want it. The key to water repellency of feathers is the feather structure and feather network, not the natural oil. The micro-structure of the wide flat part of feathers involves interlocking barbules that may number up to one million in a single feather. The zipper effect gives strength to the web, but also traps air, helping to make the feather water tight. Through all of history, men have marveled at the splendor of feathers and have attempted to duplicate their beauty. It seems fitting that birds as rulers of the sky have brilliant feathers to match their position.

Courtesy: www.netpets.org/birds/



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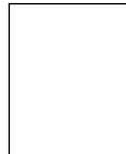
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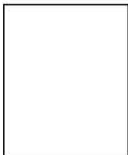
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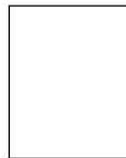
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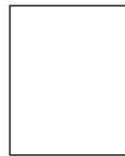
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Abdullah (may Allah be pleased with him) narrated: The Prophet (may peace and blessings of Allah be on him) said, "When you are three people sitting together then two of you should not converse privately excluding the third until you are with some other people for that would grieve him." (Bukhari-6290).

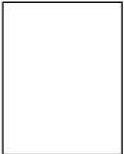
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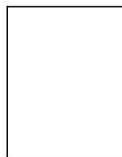
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EINSTEIN'S PUZZLE

There are 5 houses in 5 different colors. In each house lives a person of a different nationality. The 5 owners drink a certain type of beverage, smoke a certain brand of cigar, and keep a certain pet. Using the clues below can you determine who owns the fish?

- The Brit lives in a red house.
- The Swede keeps dogs as pets.
- The Dane drinks tea.
- The green house is on the immediate left of the white house.
- The green house owner drinks coffee.
- The person who smokes Pall Mall rears birds.
- The owner of the yellow house smokes Dunhill.
- The man living in the house right in the middle drinks milk.
- The Norwegian lives in the first house.
- The man who smokes Blend lives next door to the one who keeps cats.
- The man who keeps horses lives next door to the man who smokes Dunhill.
- The owner who smokes Blue Master drinks grape juice.
- The German smokes Prince.
- The Norwegian lives next to the blue house.
- The man who smokes Blend has a neighbor who drinks water.



Answer

Nationality:	Colour:	Beverage:	Smokes:	Pet:
Norway	Yellow	Water	Dunhill	Cats
Dane	Blue	Tea	Pall Mall	Horses
Brit	Red	Milk	Blend	Birds
German	Green	Coffee	Prince	Fish
Swede	White	Grape Juice	Blue Master	Dogs

The German owns the fish and the table below details the full answer. This puzzle is usually attributed to Einstein, who may or may not have written it.

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Abu Hurairah (may Allah be pleased with him) narrated: Allah's Messenger (may peace and blessings of Allah be on him) said, "By Him in whose hand is my life, none of you will have faith until I am more beloved to him than his father and his children." (Bukhari-14).



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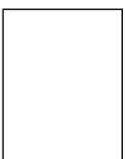
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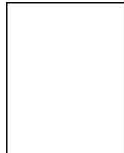
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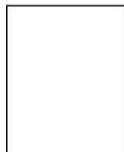
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Engineering Quiz

Which dam is largest in terms of volume of water?

- Syncrude Tailings Dam, Canada
- Aswan High Dam, Egypt
- Hoover Dam, United States
- Tarbela Dam, Pakistan

See Answer on Page: 110

Electrical Engineers



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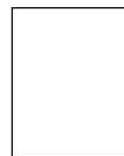
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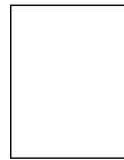
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Anas bin Malik (may Allah be pleased with him) narrated: Allah's Messenger (may peace and blessings of Allah be on him) addressed us and said in his sermon, "He has no Iman who is not trustworthy, and he has no Deen who does not keep promises." (Ibn Hiban-194).

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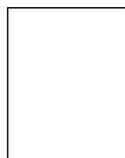
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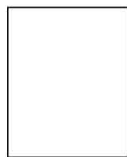
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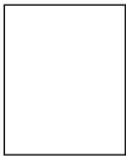
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Answer of the dam Quiz

The Correct Answer is the Syncrude Tailings Dam,
Canada

The Syncrude Tailings Dam, in Canada, is the largest dam in the world, holding approximately 540,000,000 cubic meters of water. Syncrude Tailings is a barrage dam, built only to impede water. The Aswan High Dam, Hoover Dam, and Tarbela dam hold less water back, but are more important economically as generators of electricity and sources of water for irrigation.



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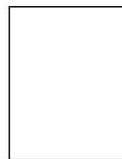
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Abu Hurairah (may Allah be pleased with him) narrated: The Prophet (may peace and blessings of Allah be on him) said, "The signs of a hypocrite are three, whenever he speaks he tells a lie, whenever he promises he breaks it, and whenever he is entrusted he betrays." (Bukhari-33).



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