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In this issue

Editor's Note..

It was a difficult issue of this Magazine, after we lost one of its pillars, the Late Mohamed El-Faluji, as he was essential motivator, editor, and reviewer of all articles and design. We pray to Allah that he will (ISA) be in a better place, in the highest position of paradise.

This issue include five articles, three of them from the electrical discipline, one from mechanical, and one on management science. Eslam Torfa who got MBA recently discussed the employee performance appraisal in two types of managements; Management by objectives vs management by project, this article as it is very important to PGESCo staff, was also reviewed by Eng. Magdy Mahmoud, who also MBA holder, and the Manger of Engineering and technology development. PGESCo valve specialist, Ata Allah Hassan, discussed over pressurizations reasons and remedy in his well-studied and full of figures article, which I think is very valuable.

Mohamed Abdel Khalek paper on Inverters used for the grid connected PV plants (parks) is a timely paper, in line with the current activity in the transmission industry to formulate a suitable Grid Code required for the Egyptian power system. Yehia Zakaria, took my admiration and present the idea of the hybrid GIS versus indoor (GIS) and outdoor high voltage switchyard. The first article we have received about 2 months ago is the one by Alaa Abdou, who presented and discussed the importance of variable frequency drive, and it can save energy if used for pump drives.

I wish you enjoy this issue of the PGESCo Engineering Magazine, and we shall be waiting to your comments, and contribution.

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Magazine team:

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Variable Frequency Drives: A way to Save Energy in Pumping Applications

Introduction

Pumping systems account for nearly 20% of the world's energy used by electric motors and 25% to 50% of the total electrical energy usage in certain industrial facilities. Significant opportunities exist to reduce pumping system energy consumption through smart design, retrofitting, and operating practices. In particular, many pumping applications with variable duty requirements; offer great potential for savings. The savings often go well beyond energy, and may include improved performance, improved reliability, and reduced life cycle costs.

Most existing systems requiring flow control make use of bypass lines, throttling valves, or pump speed adjustments. The most efficient of these is pump speed control. When a pump's speed is reduced, less energy is imparted to the fluid and less energy needs to be throttled or bypassed. Speed can be controlled in a number of ways, with the most popular type of variable speed drive (VSD) being the variable frequency drive (VFD).

BASIC PRINCIPLE OF A VFD

In the 1980's and 1990's variable speed drives (VSDs) started appearing on the market offering an alternative method of control. A VSD, also known as a 'variable frequency drive', 'frequency converter', 'adjustable speed drive' or 'inverter', is an electronic power controller that is able to adjust the electrical supply to an AC induction motor with a corresponding change in the motor's speed and torque output.

VFD technology is now mature and enjoying widespread adoption and use with AC induction motors; VFD's are extremely versatile and offer a high degree of motor control where motor speeds can be accurately varied from zero rpm through over 100% of the rated speed, whilst the torque is also adjusted to suit. In theory the basic idea is the process of transforming the line frequency to a variable frequency is basically made in two steps.

1. Rectify the sine voltage to a DC-voltage.
2. Artificially recreate an AC-voltage with desired frequency. This is done by chopping the DC-voltage into small pulses approximating an ideal sine wave.

A VFD consists basically of three blocks: the rectifier, the DC-link and the inverter.

There are three different types of VFDs:

- VSI - Voltage Source Inverter, e.g. PWM.
- CSI - Current Source Inverter.
- Flux vector control.

The CSI has a rough and simple design and is considered to be very reliable, but the output signal means a lot of noise. Furthermore the CSI induces high-voltage transients in the motor. The flux vector control is a more sophisticated type of VFD which is used in applications where the speed should be controlled very precisely. This type is expensive and pump applications cannot take advantage of its benefits. The most common type of VFD is the PWM – Pulse Width Modulation.

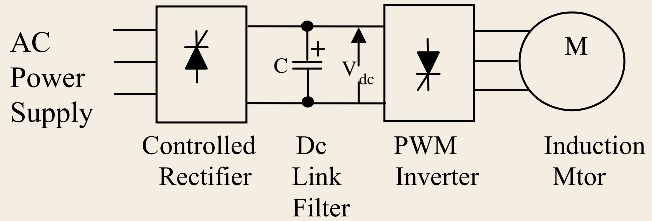


Figure 1: Variable-voltage variable– frequency (VVVF) induction motor drive system

Pump System Performance Theory

We can use the affinity laws to predict the performance of a centrifugal pump with little or no static head at any speed, if we know the pump's performance at its normal operating point. The affinity law equations are as follows:

1. Flow is directly proportional to speed: $Q2 / Q1 = N2 / N1$
2. Torque required is proportional to speed square: $H2 / H1 = (N2 / N1)^2$
3. Horsepower required is proportional to speed cubed: $P2 / P1 = (N2 / N1)^3$

Where:

Q = Volumetric flow

N = Pump rotational speed

P = Horsepower (hp)

Q1, H1, P1, N1 = pump performance at normal (initial) operating point

Q2, H2, P2, N2 = pump performance at final operating point

The power – speed relationship is also referred to as the 'Cube Law'. When controlling the flow by reducing the speed of the pump a relatively small speed change will result in a large reduction in power absorbed. If speed decreases by 50%, power consumption decreases to 12.5%. The potential of energy savings is available as the flow requirement is reduced.

Throttling Valves Control

In many flow applications, a mechanical throttling device is used to limit flow. Although this is an effective means of control, it wastes mechanical and electrical energy. Figure 2 represents a pumping system using a mechanical throttling valve and the same system using a VFD.

Pump Energy Savings with VFDs

Using a VFD to control the flow rate from a pump rather than using simple throttle control can result in large power and therefore energy savings. This is illustrated in Figure 2, where the broken line indicates the power input to a fixed-speed motor and the solid line indicates the power input to a VFD. The shaded area represents the power saved by using a VFD for a given flow.

The original fixed speed operating point (1480 r.p.m) of the pump is at (Point 1) where the system curve intersects the head-flow profile at a flow rate of 700m3/hr, the efficiency is 85.1%. If the output is regulated by a throttle the system curve effectively moves to the left (Point 2) Where the pump efficiency has declined to 78%. Conversely if the output is regulated by speed control the operating point moves down the system curve (Point 3) whilst the pump efficiency declines marginally.

On systems with a high static head, in particular pumping applications (see Figure.4) for example, boiler feed-water pumps or high lift applications, where the pump must overcome the resistance to lifting the water before any flow starts, the benefits of using VFDs will be reduced. This is because higher speeds need to be maintained in order to overcome the additional resistance due to the high static head. Factor this into any calculations (including Affinity Laws) and consult the pump supplier for further information on how to take account of static head. Typical examples of pump applications that will benefit from VFDs include circulating water in HVAC systems, boiler feed-water pumps, process pumps and

Figure.2 Pump power saving when flow regulated by throttle valve vs. speed reduction

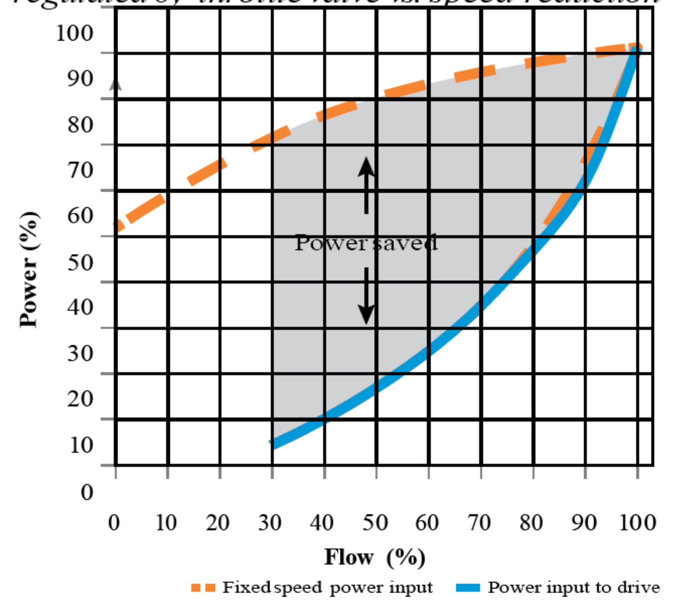


Figure 3 Pump efficiency, throttle valve control vs. speed reduction

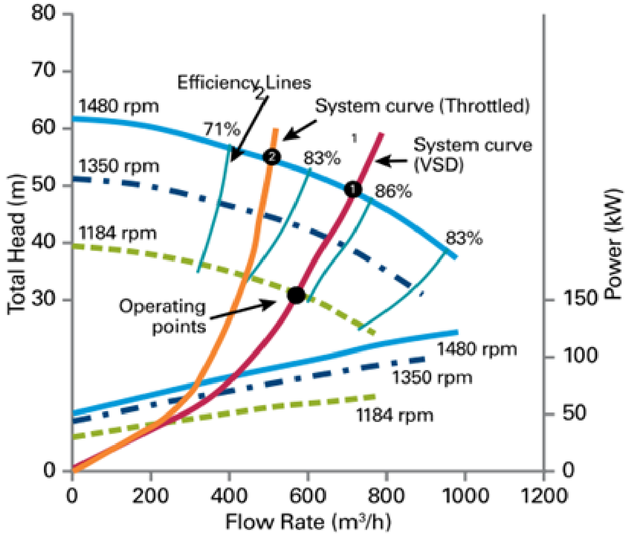
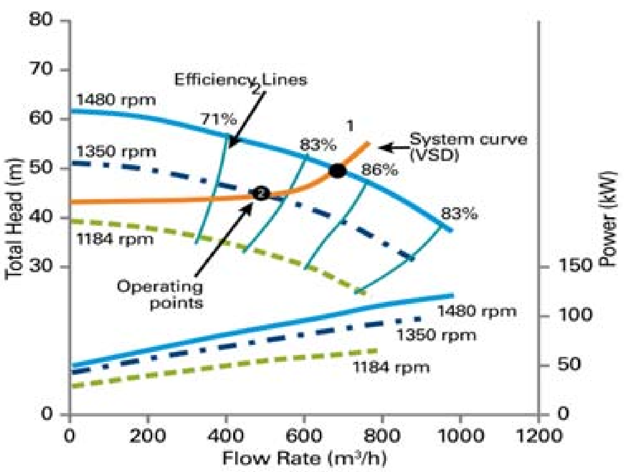


Figure 4 Effect of high static head on system head-flow curve



VFDs for further cost savings

The use of VFDs can bring further total system cost reductions, due to the elimination of components required for valve control only. In a valve flow control system, there are losses in the valve and additional piping required to bring the valve to a height where it can be adjusted. In the previous example Figure.5, the piping loss is 10 hp, and the valve loss is 15 hp.

Because of these losses and the internal pump loss, to obtain a head equivalent to 50 hp, an equivalent of a 90 hp pump and a 100 hp motor is required. With the use of the VFD, there are no valve or pipe losses due to bends or additional piping, thus reducing the piping losses to 8 hp. With the reduction of these losses, a smaller pump can be used with lower losses. For the same equivalent of 50 hp of head, only a 68 hp pump and a 75 hp motor are required. This results in a substantial system cost and installation savings, further economically justifying the use of the VFD.

Limitations of VFDs

Although using VFDs can help to reduce operating and maintenance costs, they are not appropriate for all applications. As a pump's speed decreases, it generates less pressure. In high-static-head applications, the use of VFDs can slow a pump down so that it operates at or near shut-off head conditions. The pump thus experiences the same harsh conditions that the manufacturer attempts to guard against when setting a minimum flow rate, which usually corresponds to the pump's rated speed. The consequences include greater shaft deflection, high vibration levels, and high bearing loads.

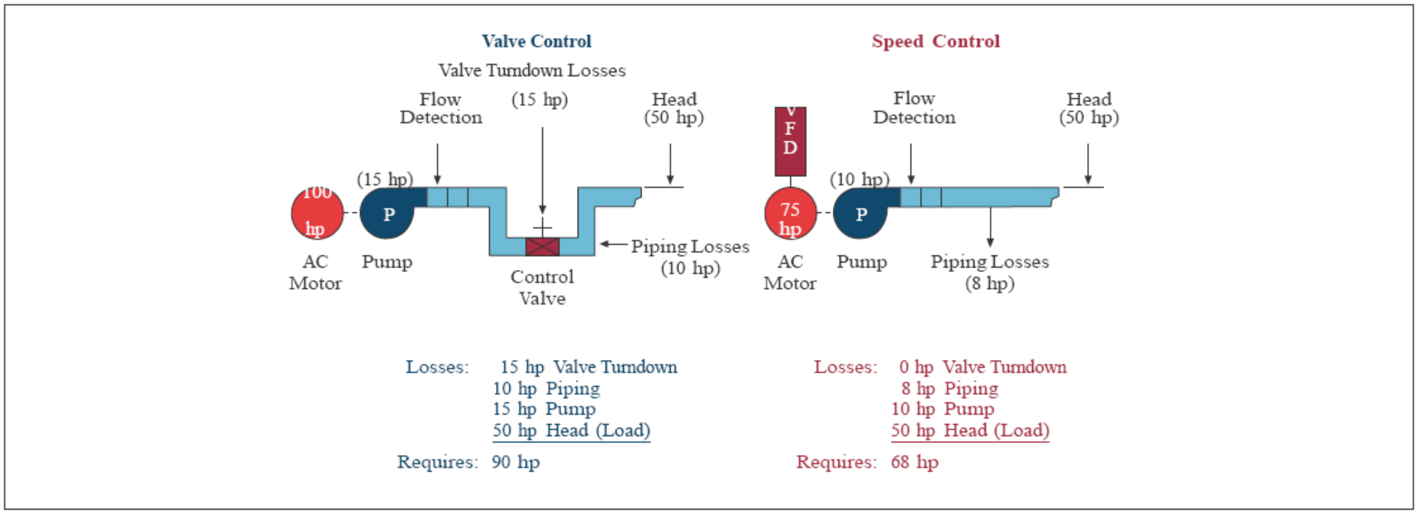


Figure.5 Energy Savings Can Be Calculated with a Computerized Analysis

Power quality can also be a concern. VFDs operate by rectifying the alternating current (ac) line power into a direct current (dc) signal, then inverting and regulating this signal into ac power that is sent to the motor. Often, the inverter creates harmonics in the power supplied to the motor. These harmonics can cause motor windings to operate at higher temperatures, which accelerates wear in insulation. To account for the added winding heat, motors are typically derated 5% to 10% when used with VFDs. A classification of motors known as "inverter-duty" has been developed to better match VFDs with motors.

In some electrical systems, the harmonics created by the inverter can be picked up by other electrical lines that have common connections with the VFD. Systems that are sensitive to minor disturbances in power supply should be served separately from the VFD power supply.

In some applications, VFDs contribute to reduced bearing life. The interaction between the three phases of the power supply from a VFD inverter sometimes induces a small voltage across the motor bearings. As a result, these bearings can experience pitting and accelerated wear. VFD manufacturers are familiar with this problem, and several methods can be used to correct it. These methods include insulating certain bearings, grounding the shaft, and conditioning the power supply. Finally, anticipated energy savings are not realized in some applications because some of the losses associated with VFD installation were not taken into consideration. The VFDs themselves are approximately 95% to 97% efficient, and motor efficiency generally begins to decrease at less than 75% of full load. In addition, the quality of electric power supplied to the motor can affect both its efficiency and its power rating. Although VFDs are an attractive option in many applications, all these considerations should be incorporated into a feasibility study before VFDs are installed.

BIOGRAPHY:-

Alaa Abdou; He received the B.Sc. Degree in Electrical Power & Machines Engineering from Cairo University in 2001. For the time being He is working as Deputy Electrical Engineering Group Supervisor in power plants projects. He is interested in High voltage substations, medium and low voltage systems design.

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Grid Integration Compatibility Functions of PV Inverters

Solar photovoltaics (PV) is the dominant type of distributed energy resources (DER) technology interconnected to electric distribution systems worldwide and deployment of PV systems continues to increase rapidly.

The key drivers behind the massive deployment of Solar PV Technologies including the continuous drop of PV energy price that is currently close to conventional power generation technologies especially for large scale PV Parks, in addition to the successful implementation of governmental incentives and financial schemes for Solar PV technology deployment.

In the past, with low penetration level of PV generation, the grid connected PV systems are not required to support the grid, but currently with this high level of PV penetration into electrical power systems, worldwide Grid code requirements has been evolved to identify the required performance features of PV power plants to support grid operation and stability.

The paper will focus on some of the compatibility functions of PV grid tied Inverters to support grid interconnection requirements. Namely, the following features will be addressed.

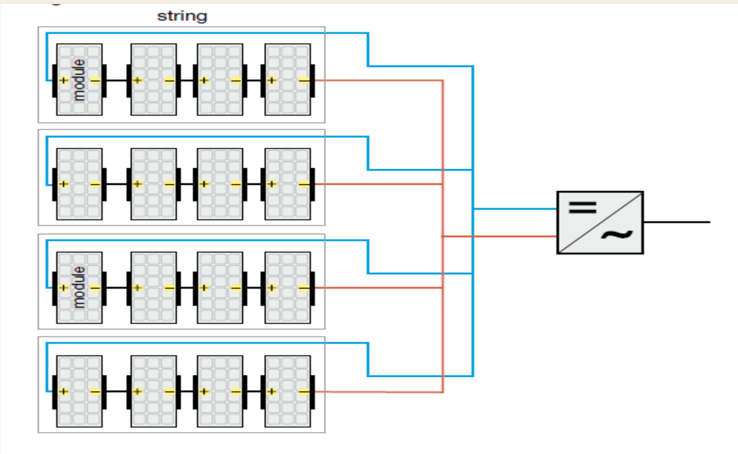
- Active Power Control (Ramp Control)
- Reactive power control
- Dynamic Vs Static Reactive Support
- Low Voltage Ride Through (LVRT)

Additional feature may be discussed later in a separate paper.

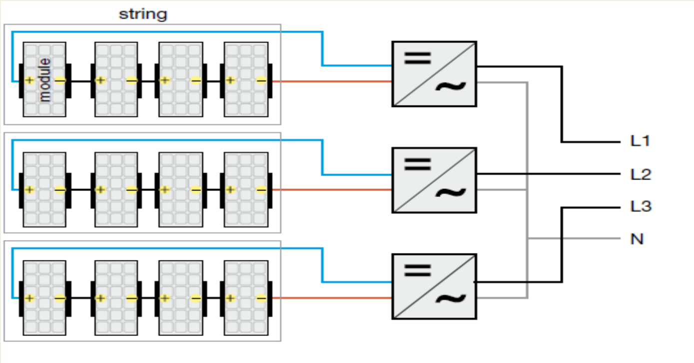
PV Park Architecture

The components of a large-scale PV plant work together to transform the energy from the sun into grid-compatible AC electricity. The connection of the strings forming the solar field of the PV plant can occur in many different ways as illustrated below

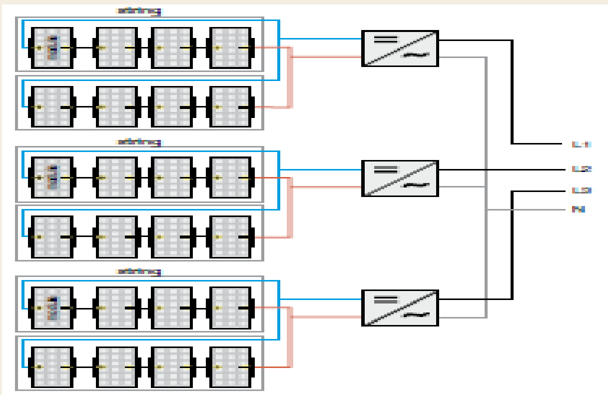
1. One central inverter(s) for all the plant (Figure 1),
2. One inverter for each string (Figure2),
3. One inverter for multiple strings (multi-inverter plant) (Figure3),



(Figure 1)



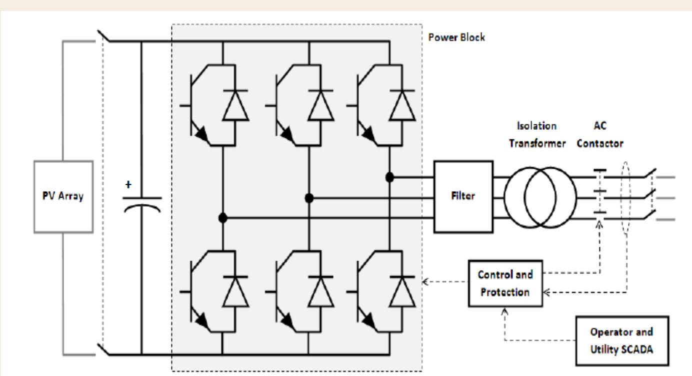
(Figure 2)



(Figure 3)

PV Inverters

The inverter is a power converter which converts the DC supplied by the PV generator into AC that has the same voltage and frequency as the grid (figure 4). The inverter represents the link between the solar generator and the public power grid, and must therefore perform several tasks simultaneously. The most important of these are MPP tracking (control the DC voltage to ensure that the PV array operates at maximum power) and converting the solar modules' DC into grid-compatible AC.



(Figure 4)

The rating of power converters for large-scale solar plants today is typically 250 kW; however, 1-MW converters are just starting to appear. Recently, it has also assumed new tasks for grid compatibility functions such as anti-islanding and reactive support as will be discussed later in much more details.

Inverter grid compatibility functions

With the very high penetration of utility interconnected photovoltaic (PV) power plants, today's utilities interconnection standards are evolving to allow the PV grid tied inverters to support grid voltage and frequency and to ride through power system faults. With introducing of Multi MW sized PV plants connected to the grid, the PV inverters have to react actively to support the grid not to disconnect at the first sign of fault.

We will start introducing PV Inverters grid support functions individually.

1- Active Power Control (Ramp Control)

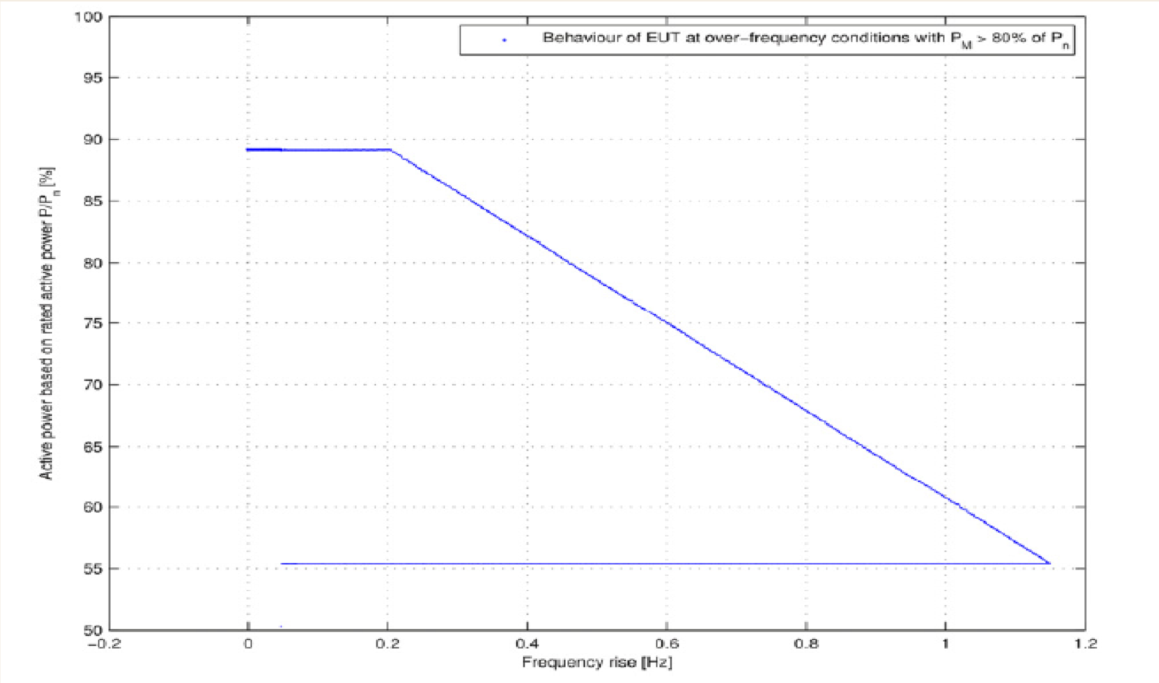
The new functions for active power control enable the Inverter to reduce the actual power output in terms of network instabilities. Whether this power reduction is done locally and automatically due to an over-frequency situation in the network or it has to be done remotely by the network operator.

Power reduction at over-frequency condition

A surplus on generation capacity in the network leads to a frequency rise. If conventional frequency control of the network is no longer capable to keep the frequency in acceptable range, PV grid tied Inverters should support the network by reducing active power injection.

The setting of active power reduction will be different from utilities to another and from grid operator to another, some standard interconnection requirement asks for an active power reduction with droop setting slope 40% per Hz starting at 50.2 Hz.

Figure 5 below shows measurement results when the network frequency is varied by the AC-network simulator. It is obvious that inverters are well suited for providing this functionality.

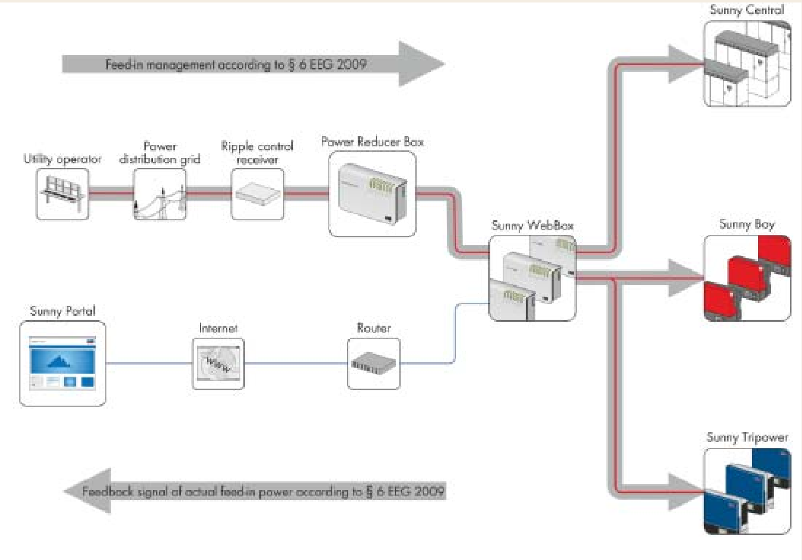


(Figure 5)

Power reduction by network operator

In case of network transmission capacity shortages or overloading of network equipment the network operator is allowed to reduce the active power injection of PV grid tied Inverters in order to secure network operation. The PV grid tied Inverters must be able to reduce the active power output to set-points given as percentage of the rated active power. Most common values are 100%, 60%, 30% and 0%.

Response time of the PV grid tied Inverters should be faster than 1 minute. It has to be considered that this time range have to cover the whole communication line beginning from the receipt of the set-point signal at the plant controller until the alignment of the reduced active power output at PV grid tied Inverters. (Figure 6)



(Limit power generation via remote control and SMA Power Reducer Box)

(Figure 6)

2- Reactive power control

In the past, PV inverters is not required to contribute to voltage control of the system accordingly no reactive power control is required, currently with the high penetration of PV grid connected power plants, voltage control becomes an important issue nowadays. The current-carrying capacity of the semiconductors is the limiting factor for reactive power provision of inverters. An over-dimensioning of the inverter is required if a simultaneous injection of reactive power at rated active power is desired (figure 7). Otherwise the maximum active power injection has to be limited. This could involve higher system costs to the manufacturer.

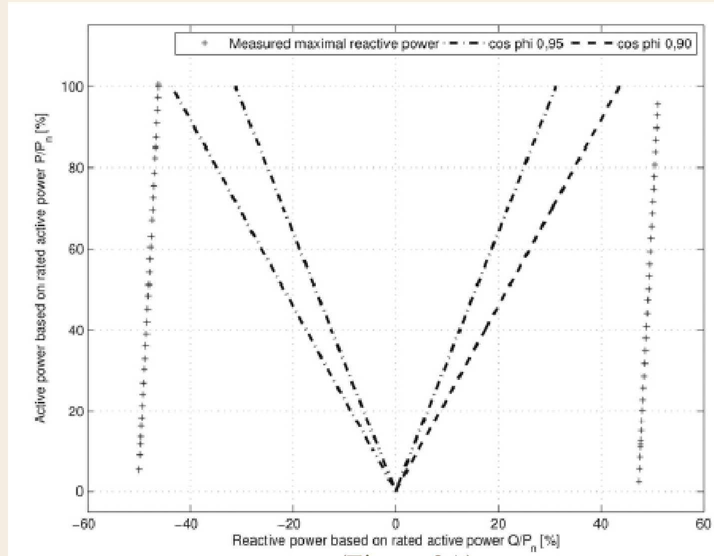
Current grid codes demands a power factor of 0.95 leading and lagging at the Point of Common Coupling (PCC) (figure 8 A&B). In order to fulfill this requirement, inverters should be able to provide a lower power factor than 0.95, since the reactive power demand of internal network equipment as cables or transformers also has to be considered.

The network operator has following possibilities for setting the reactive power:

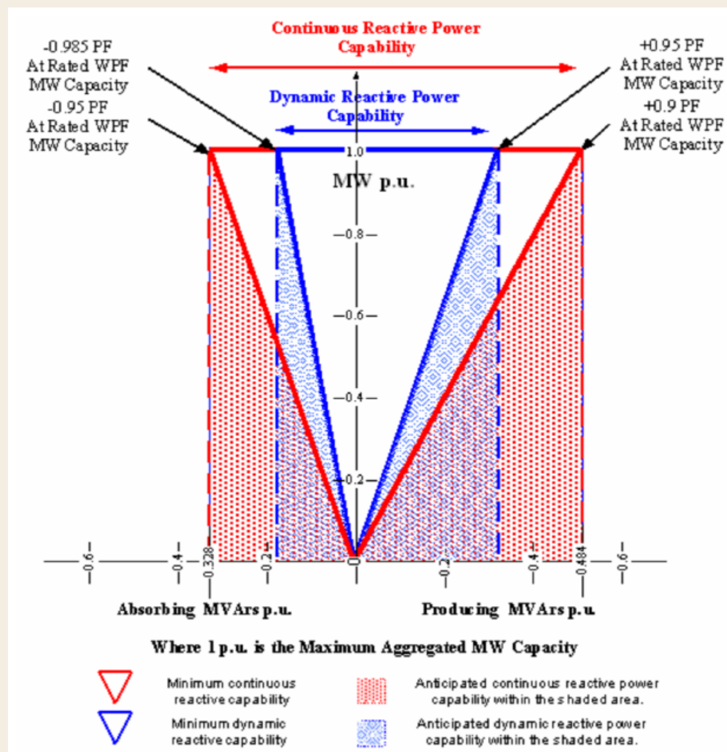
- Fixed power factor cos φ,
- Fixed reactive power in MVAr,
- Characteristic curves:
  - Power factor and active power cos φ(P),
  - Reactive power and voltage Q(U),

Characteristic curves are frequently used when the PV plant strongly influences the voltage at the connection point. Technically, a plant with inverter-based solar generators could rely on the inverters to provide part or all of the necessary reactive power range at the POI. It may be more economical to use external static and dynamic devices such as a STATCOM (static compensator), an SVC (static VAr compensator), or MSCs (mechanically switched capacitors).

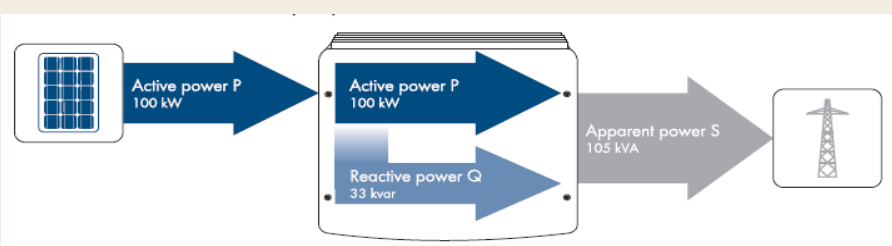
The additional amount of reactive support required depends on the reactive capability of individual PV inverters and how the reactive support is utilized. Sometimes, external dynamic reactive support is required to assist with voltage ride-through compliance.



(Figure 8A)



(Figure 8B)
Reactive Power Capability Requirement for AESO
(The Alberta Electric System Operator)



Influence of the power factor cos φ, or reactive power share, on the active power of the inverter.

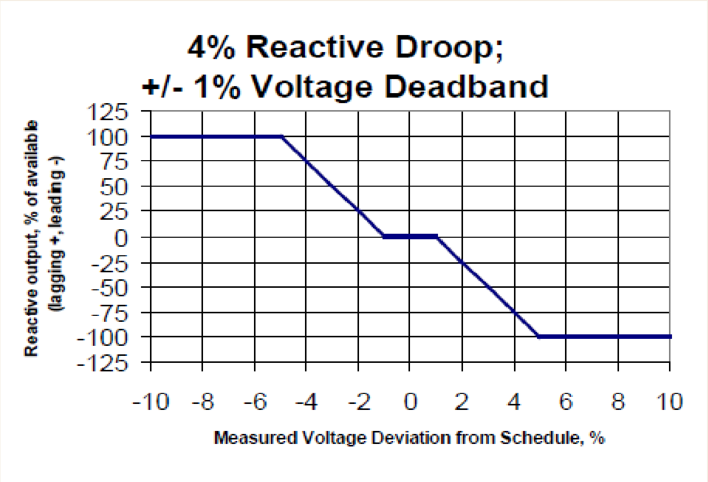
(Figure 7)

3- Dynamic Vs Static Reactive Support

The provision of dynamic reactive capability may have cost implications different than those of static reactive capability and thus should be separately specified. Some grid codes specify both a dynamic range and a total range of reactive operation. For example, a grid code may specify a dynamic range of 0.95 lag to lead and a total range of 0.90 lag to 0.95 lead, indicating a need for smooth and rapid operation between 0.95 lag and 0.95 lead, but allowing for some time delay for lagging power factors below 0.95. Dynamic reactive capability from converters can be provided almost instantaneously in a manner similar to that of synchronous machines. (Figure 9)

The specifications of the reactive droop requirement (e.g., the deadband of the droop response, together with the response time to voltage changes) may lead to requirements for dynamic reactive power support as well as potentially fast-acting plant controller behavior. Reactive droop capability is an emerging capability for solar PV plants, although there are no technical impediments to the implementation of such control schemes.

PV inverters typically follow a power factor, or reactive power, set point. The power factor set point can be adjusted by a plant-level volt/var regulator, thus allowing the generators to participate in voltage control. In some cases, the relatively slow communication interface (on the order of several seconds) of inverters limits the reactive power response time.

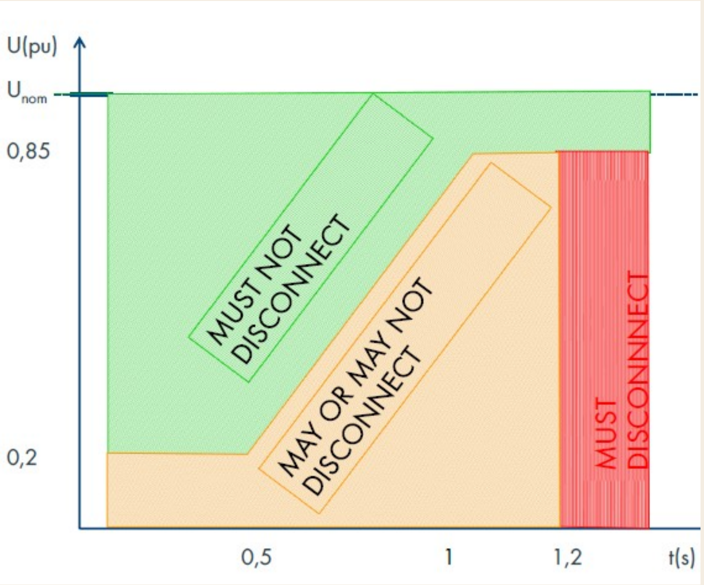


(Figure 9)

4- Dynamic Grid Support (LVRT)

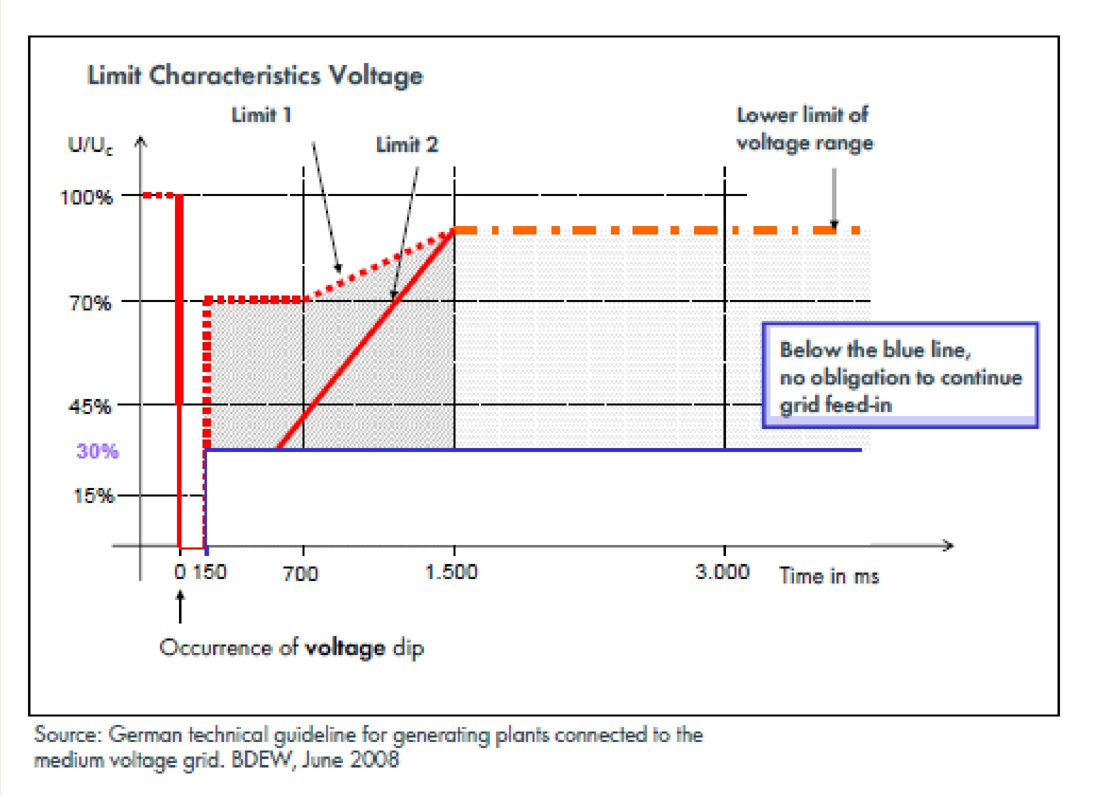
The simple definition of LVRT is the capability of the PV power plant to stay connected to the network and keeps operating following voltage dips or surges caused by short -circuits or disturbances on any or all phases in the transmission system or distribution system.

In the past, local power generation plants had to disconnect from the grid at the first sign of fault, this requirement has become problematic in light of today's significant power generation capacity, as even brief system incidents that are generally easy to manage could result in the sudden disconnection of larger power generation capacities under certain circumstances, resulting in an energy imbalance of the grid.



(Figure 10)

Currently most of grid codes now requires PV inverters to support the grid in case of an incident by "riding through" voltage drops of up to several seconds and then resuming normal feed-in immediately afterwards (so-called low-voltage ride-through, or LVRT). The inverter behaves passively throughout the course of the error in the limited version. The device also needs to feed reactive power into the power distribution grid during a voltage drop in the complete version of the LVRT. As a result, they contribute to the resolution of the incident and help to trigger the grid protection devices. (Figure 10&11).



(Figure 11)

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BIOGRAPHY:-

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IEEE Member, Affiliate Member of European Renewable Energy Center, IEC TC-88 (Wind Turbines) Working Group Member, IEEE Standard Association and PES Member Power Engineering Society Transaction Papers Reviewer.

Mohamed is currently Electrical Engineering group supervisor for SUEZ project, in addition Mohamed is a member of PGESCo Renewable Energy Group.

Mohamed Completed several professional development activities in Renewable Energy Technologies, Smart Grid and Renewable Energy Integration at several International institutions, TU Delft University Netherland, University of Washington USA, and Renewable Energy Center Germany

Hybrid Insulated Substations for Fast Track and IPP Project's Requirements

The need for quick installation, emergency plans, compact schedules by developers and Independent Power Providers (IPP), in addition to the increasing number of requests of renewable energy connections in the recent years has intensified both need and urgency to identify innovative solutions suitable for connecting the new plants to the transmission grid. Consultants, manufacturers and contractors have to come up with fast-to-implement, economical, reliable, environment-friendly, and easy-to-maintain solutions. Interconnecting High Voltage Substation is one of the key elements that determine the project's capability to fulfill such tough schedule challenges.

This Article is a quick overview for the current high voltage switchgear technologies. We will represent the Hybrid Insulated Substation (HIS) installation as a relevant answer to the recent needs of "quick to implement solution" for HV and EHV substations.

Substation Configuration

Substation can be classified, based on design configuration, to: Air Insulated Substation (AIS), Gas Insulated Substation (GIS), and Hybrid Insulated Substation (HIS), which combine two insulation media (i.e. air and SF6). Each configuration has its advantages and disadvantages as follows:

Air Insulated Electrical Power Substation (AIS):

In Air Insulated Substations busbars and connectors are visible bare conductors. Circuit Breakers and Isolators, Transformers, Current Transformers, Potential Transformers etc are installed in the outdoor. Busbars are supported on the post Insulators or Strain Insulators. Substations have galvanized Steel Structures for supporting the equipment, insulators and incoming and outgoing lines. Clearances are the primary criteria for these substations and occupy a large area for installation. AIS could also be installed indoor up to 72kV level.

Advantages:

- Less component cost,
- Short repair time (for equipment replacement and fault allocation),
- Installation flexibility (It enables to replace an element from a given supplier by another one from another supplier),
- It features low initial costs, as far as land costs and civil works remain moderate,
- No big civil structural required.

Disadvantages:

- Less reliable; because of its exposure to atmospheric air, moisture, contamination, etc,
- Require more maintenance,
- Require large space; because of the required clearances area,
- High equipment installation cost,
- High visual effect.

Gas Insulated Electrical Power Substation (GIS):

A gas-insulated substation (GIS) uses a superior dielectric gas, SF6, at moderate pressure for phase-to-phase and phase-to-ground insulation. The high Voltage conductors, circuit breaker interrupters, switches, current transformers, and voltage transformers are in SF6 gas inside grounded metal enclosures. The atmospheric air insulation used in a conventional, air-insulated substation (AIS) requires meters of air insulation to do what SF6 can do in centimeters. GIS can therefore be smaller than AIS by up to a factor of 10. A GIS is mostly used where space is expensive or not available. As a result, GIS is more reliable and requires less maintenance than AIS.

Giza North 500 kV GIS

Advantages:

- It is the best solution in terms of compactness and reliability (due to encapsulated technology),
- The most reliable substation configuration; as active parts are protected from the deterioration from exposure to atmospheric air, moisture, contamination, etc.,
- It is well adapted to stringent environmental constraints such as heavily polluted areas (for instance industrial areas or sea shores), low temperatures and icing conditions, strong earthquake withstand, etc.,
- Require less maintenance,
- Less equipment installation cost,
- High degree of safety,
- It is easy to integrate in locations where visual impact has to be optimized.

Disadvantages:

- High initial cost
- Long repair time (long time for equipment order and replacement),
- Less installation flexibility (It is difficult to replace an element from a given supplier by another one from another supplier),
- Long project execution time (large civil structural required).

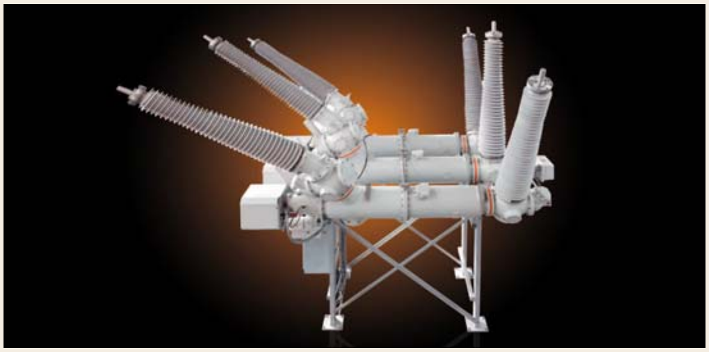
Hybrid Insulated Substation (HIS)

Hybrid Insulated Substations are the combination of both Conventional Air Insulated Substation and Gas Insulated Substation. We must also point out that combination of GIS feeder with air-insulated busbars is not new: it is used since the beginning of GIS technology, however in rare cases.

The evolution of HIS

Real revolution came after research led to the use of gas-insulated modules (GIM) instead of traditional air-insulated (AIS) or fully gas-insulated (GIS) solutions. This module normally includes all needed functions: circuit-breaker, disconnectors, earthing switches (low or high speed), current transformers, voltage transformer and SF6-air bushings. GIM units could be installed outdoor and connected to OHTL and using visible bare busbars as applied in the AIS.
GIM use has been extended to different categories of application. In the same time, it has been extended to the EHV levels of transmission networks, such as 420 and 550 kV.

The main advantage of the HIS is its combination for several advantages of both traditional AIS and GIS.



Gas Insulated Module (GIM), 145kV, ABB

Advantages

- Up to 60% space saving relative to AIS,
- Significant reduction of air-insulated insulators than AIS,
- Reduced installation costs because of minimal civil construction works,
- It provide reliability level close to the GIS as all switching equipment protected and sealed (this also solves AIS disconnector problems under severe ambient conditions)
- It provides earthquake withstand similar to GIS one (Use of composite silicon rubber insulators),
- Short repair time,
- High degree of safety (no manual operation under OHTL),
- Improved flexibility in terms of equipment exchangeability ,
- Easy combination of HIS from different manufactures. Even combination of HIS with other single apparatus AIS is possible,
- Require limited maintenance,
- No necessity of manual grounding,
- Significant reduction of resources, raw material and energy,
- All components are completely factory-tested as one pole assembly,
- They also have the advantage of being offered by most or all of the main suppliers. This should ensure competitive pricing and also provides insurance that the design layout will not be dependant on a single supplier,
- Extremely short project execution time,
- Gas leaks and arc flash happens most probably from GIB connections rather than breaker or switches compartment,
- Reduction of CO_2 emission during the whole life-cycle process by 77%,

Disadvantage

Actually we can say that combining the advantages of AIS and GIS leaves the HIS, almost, without absolute disadvantages. The disadvantages will be relative to the course of application. Even some of these disadvantages have been claimed by the manufacturers to be solved with the modern GIM and other measures. Some of the relative disadvantages are:

- Less durability, relative to GIS, to the deterioration from exposure to atmospheric air, moisture and contamination,
- Require larger space relative to the GIS,
- High visual effect.

Land use of AIS vs. HIS

The durability issue of the HIS is addressed by an explicit requirement for a 45 years lifetime for the S/S and for a very high quality surface treatment, which was assessed as being adequate by metallurgy expert. Additional layer of protecting coating including galvanizing plus painting for supporting structure could be applied. Special seal nuts to protect any ingress of moisture in the sealed parts or using duplex sealing system are examples of the measures that could elevate the durability of the HIS to the level of the GIS.

Economics of the GIS

The equipment cost of GIS is naturally higher than that of AIS due to the grounded metal enclosure, the provision of an LCC, and the high degree of factory assembly. A GIS is less expensive to install than an AIS. The site development costs for a GIS will be much lower than for AIS because of the much smaller area required for the GIS. The site development advantage of GIS increases as the system voltage increases as high voltage AIS takes very large areas because of the long insulating distances in atmospheric air. Also, the GIS requires large civil. Cost comparisons in the early days of GIS projected that, on a total installed cost basis, GIS costs would equal AIS costs at 345 kV. For higher voltages, GIS was expected to cost less than AIS. However, the cost of AIS has been reduced significantly by technical and manufacturing advances (especially for circuit breakers) over the last 30 years, but GIS equipment has not shown any cost reduction until very recently. Therefore, although GIS has been a well-established technology for a long time, with a proven high reliability and almost no need for maintenance, it is presently perceived as costing too much and is applicable in cases where space is the most important factor or where there is environmental constrains. Currently, GIS costs are being reduced by integrating functions. GIS space advantage over AIS increases. GIS can now be considered for any new substation or the expansion of an existing substation without enlarging the area for the substation.

The time factor have been presented also as an important economic factor the time required by the civil structure for the GIS building and time required for installing the large amount of AIS equipment, becomes a considerable factor that effect the completion date of the project. Fast Track project and IPP look for the early finish date of the project as a net profit that can't be neglected. Hence the HIS is introduced as economical solution.

HIS require no large civil structure and provide a high reliability level, it is introduced as an economical solution that saves time and gains money. HIS can even provide a competing cost compared with AIS substations, In general the equipment cost was higher than the AIS equipment but this additional cost was counterbalanced by the reduced land cost, reduced civil works cost and the impact of the shorter construction time.

The following areas are being the most contributed to cost reduction:

- Reduction in site dimensions (land cost),
- Reduced construction costs because of minimal civil works,
- Reduction of the quantity of the air insulated insulator,
- Reduction in installation cost (GIM are factory assembled),
- Reduction in engineering costs (the use of standard modules),
- Reduction in testing and commissioning cost (as GIM are factory tested),
- Reduction of all the above mentioned items includes reduction of workmanship.

Project execution time

The HIS can provide an extremely short project execution time because of the following:

- Short engineering and delivery times as the GIM are standard modules,
- Reduction of construction time as no big civil structure is required,
- Rapid installation time as the GIM combine most of the equipment in a preassembled module,
- Substantial reduction of on-site testing procedures, as the GIM is factory tested,
- Prefabricated enclosure can replace conventional concrete buildings by prefabricated enclosures (to provide distributed control and protection) delivered with all internal wiring completed, which significantly reduces the installation time.

It is worth mentioning that the need for compact schedule is not just needed by IPP and fast track projects. The considerable number of renewable energy introduced to the network also require a fast to implement S/S. most of the renewable energy plants has shorter project time schedule relative to the thermal or other conventional power plants. The matter, which require a fast to implement S/S to evacuate power once the plant is completed.

Conclusion

HIS provides an innovative solution that meets the need for quick installation, emergency plans, compact schedules by developers and Independent Power Providers (IPP), in addition to renewable energy projects.

HIS provides an economical, fast-to-implement, reliable, environment-friendly and easy-to-maintain solutions. HIS even can compete with AIS in a certain areas. And fulfill requirement of HV and EHV installation. It is expected that HIS will represent the future of Substation installation and it will show increasing installation rate in the current decade.

Table 1 gives a quick comparison between the difference substations technology and could be used as a guide to select the most suitable technology according to the applications.

H: High, M: Moderate, L: Low

	Cost					Reliability And Environmental withstand ability	Maintenance Requirements	Repair Time	Interchange-ability Between Different Manufacturers & Expandability (Installation flexibility)	Visual effect	Time to Implement (Schedule)			
	Material *1	Land *2	Installation (including civil)	O&M	Overall						Manufacturing	Installation	Testing and commissioning	Overall
AIS	L	H	M	H	L	L	H	L	H	H	L	M	H	M
GIS	H	L	H	L	H	H	L	H	L	L	H	H	H	H
HIS	M	M	L	M	M	M	M	M	H	M	M	L	L	L
Most Appropriate S/S *3	AIS					GIS	GIS	AIS	AIS	GIS	HIS*3			

Table 1 - HV & EHV S/S Configuration Comparison

*1 Material is the most effective item in S/S cost

*2 Land in special circumstances could be the most effective item in cost (i.e. in metropolitan areas)

*3 According to the column absolute selection criteria. However, other configuration could be better if more than item added to the selection criteria (e.g. HIS in cost, maintenance & reliability criteria)

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Biography:

Yehia Zakaria: Senior Engineering Group Supervisor PGESCo. BSc. electrical power systems and machine design 1994, Helwan University, Graduated study in Smart Grid Planning, University Of Washington, IEEE member, PMP from Cambridge Institute Shared in the construction and design of more than 5.8 GW Total Installed Capacity for the Egyptian national grid in addition to several infrastructure and industrial project in the middle east.

Over Pressurization, Pressure Locking and Thermal Binding

This article is an overview of the over pressurization, pressure locking and thermal binding phenomena which could be found in the gate valves.

Introduction

Under certain conditions, some double-seated valve designs are capable of sealing simultaneously against pressure differential from the center cavity (figure 1) to the adjacent pipe in both directions. A circumstance in which the center cavity is filled or partially filled with liquid and subjected to an increase in temperature can result in an excessive buildup of pressure in the center cavity that may lead to pressure boundary failure. An example is a piping system in which liquid from the condensing, cleaning, or testing fluids accumulates in the center cavity of a closed valve. Such accumulation may result from leakage past the upstream seat of the valve. If, during subsequent startup, the valve is not relieved of the liquid by partial opening of the valve, or by some other method, the retained liquid may be heated during warm-up of the system. Where such a condition is possible, it is the responsibility of the user to provide, or require to be provided, means in design, installation, or operation procedure to assure that the pressure in the valve will not exceed that allowed by valve design Standard for the attained temperature.

OVER PRESSURIZATION:

A gate valve in close position can retain a volume of water in the body cavity. An increase of the temperature will consequently increase the pressure in the body cavity with the risk of relevant damages of the body and the bonnet, See figure 2 and 3.

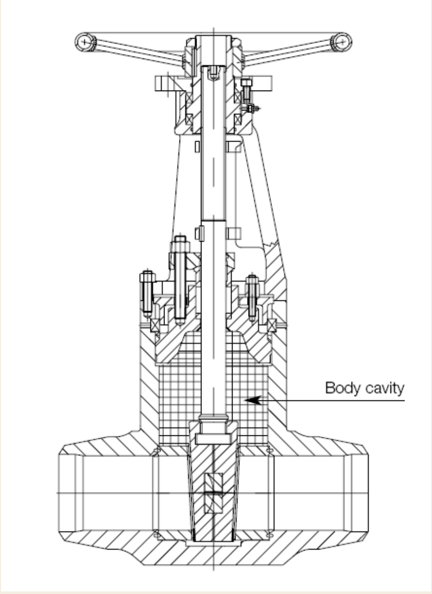

Figure 1

The entrapped water in the valve cavity

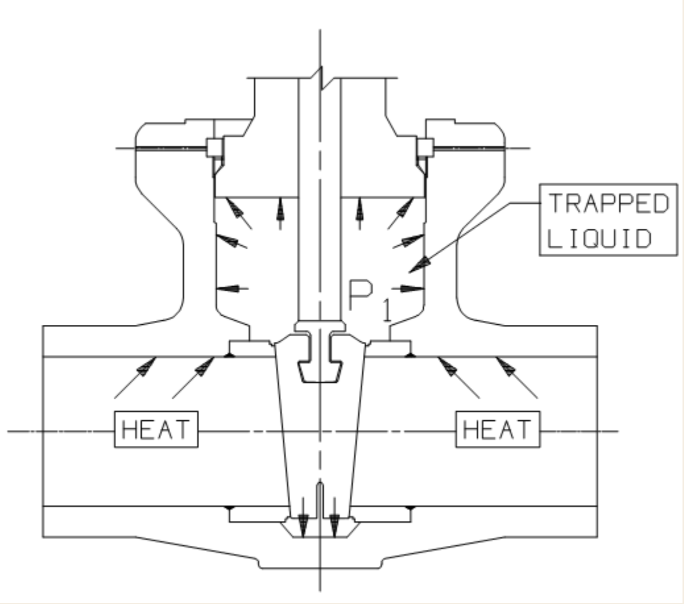

Figure 2

Over pressurization

P1: Pressure of trapped liquid between seats and in t he valve cavity

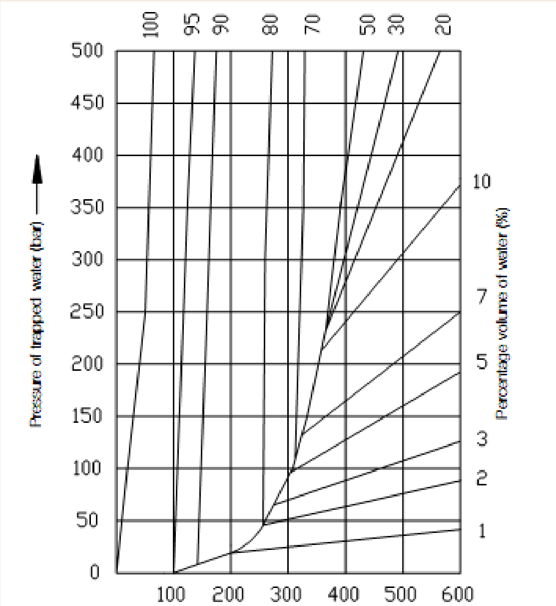

Figure: 3

Calculating of the over pressurization depending of th e differential temperature and the percentage volume of water

Pressure locking

Occurs when the pressure in the body cavity increases, or when the line pressure decreases without decreasing the body cavity pressure. This can cause inoperability of the valve closure member, see figure 4.

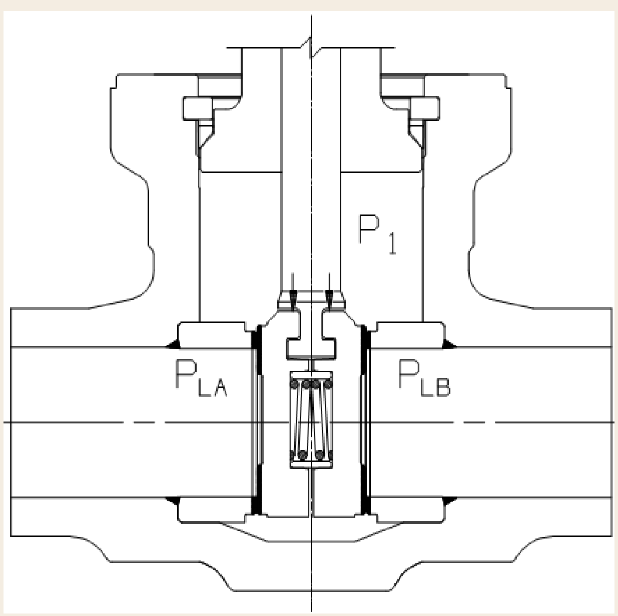

Figure 4

Pressure Locking

P1: pressure of trapped fluid between seats

PLA and PLB : line pressure

Thermal binding

Thermal binding is generally associated with a wedge gate valve that is closed while the system is hot and then is allowed to cool before attempting to open the valve. Mechanical interference occurs because of different expansion and contraction characteristics of the valve body and disc. Thus, reopening the valve might be prevented until the valve and disc are reheated, because of an increase in wedge gate valve opening thrust. The increase in opening thrust can cause the valve to fail to open because the required stem thrust exceeds the actuator's capability. See Figure 5.

Solid wedge gate valves are most susceptible to thermal binding. However, flexible wedge gate valves experiencing significant temperature changes or operating with significant upstream and downstream temperature differences may also thermally bind. Parallel disc gate valve designs are not susceptible to thermal binding. Differential thermal expansion of components should be carefully considered in high temperature valve design. Problems created by differential thermal expansion can be caused by both temperature differences and coefficient of thermal expansion differences.

Thermal binding in gate valves can be caused by many factors including:

1. The coefficient of thermal expansion of the gate material (αgate) is different from the coefficient of thermal expansion of the valve body material (a body). The opening thrust tends to increase when:
   a. The valve temperature during opening is lower than the valve temperature during closing and $\alpha gate < \alpha body$.
   b. The valve temperature during opening is higher than the valve temperature during closing and $\alpha gate > \alpha body$.

Under either of these conditions, the change in temperature tends to increase the disc-to-seat interference and opening thrust.

2. The average temperature of the gate is less than the average temperature of the body. As the temperature of the gate increases after closing, the gate expands causing additional gate-to-seat interference, which increases the opening thrust.
3. The stem temperature during closing is less than the stem temperature after closing. As the stem temperature increases, the stem compressive force increases, and the disc is forced deeper into the seat.

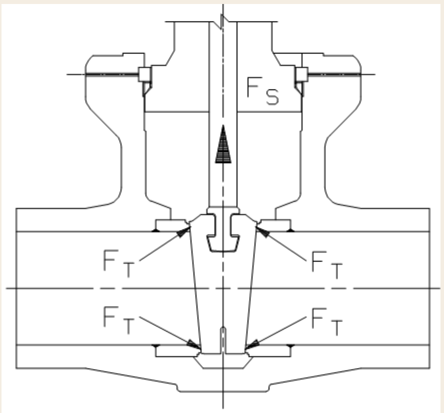

Figure 5
Thermal Binding
FS: Thrust required to lift wedge
FT: Thermal binding load

Solutions

Solutions for over pressurization and pressure locking:

One or more of the methods itemized below can be used to prevent trapping body pressure:

1. Drill a hole in the upstream seat ring see figure 6
2. Drill a hole in the upstream disc, to connect the body cavity to high pressure side of the valve. The valve will seal in one direction only. see figure 7
3.

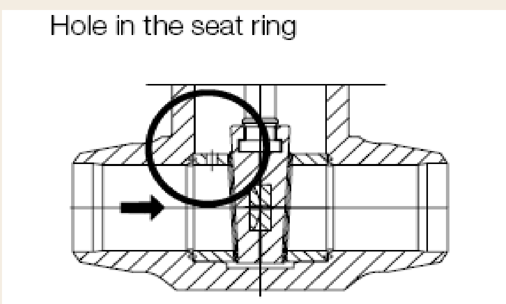

Figure 6

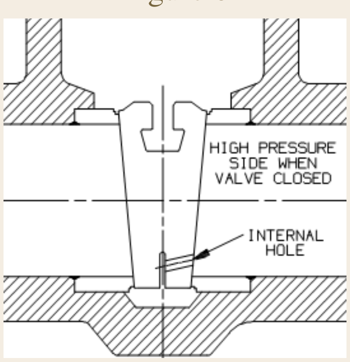

Figure 7

3. Install external bypasses to connect the body cavity to the high pressure side of the valve. The valve will only seal in one direction so the high pressure must be on the side of the equalizing pipe when valve closed. See figure 8.

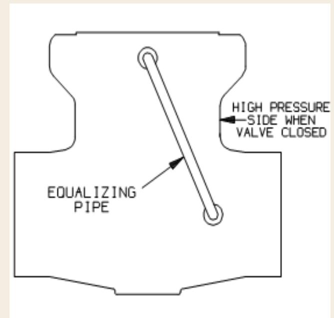

Figure 8

4. Adding an equalizing pipe and equalizing valve. The valve can seal from both sides, when the equaling valve is closed, the body cavity pressure relief is not available when the equalizing valve is closed. see figure 9

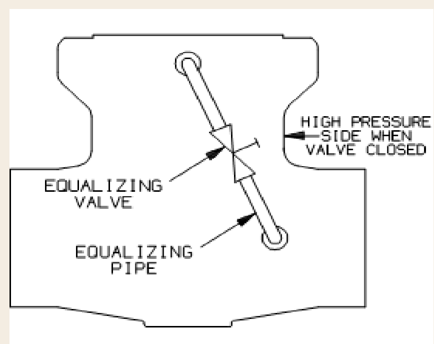

Figure 9
Equalizing pipe with equalizing valve

5. Install a non-functioning upstream seat (for example, with a notch across the face), this is not a preferred solution.
6. Install a relief valve to vent excessive pressure from the body cavity. see figure 10

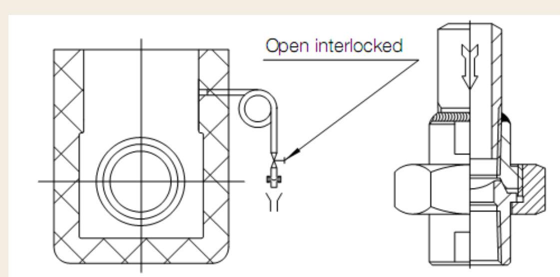

FIGURE: 10
Relief valve, Self activating

7. Connecting the body cavity to the atmosphere by a drain valve, caution must be used when opening the drain valve. see figure 11

SOLUTIONS FOR THERMAL BINDING:

A bypass pipe and bypass valve figure 12 will allow warm up of both sides of the wedge. Note that warm up lines located far away from the valve do not have a significant impact on thermal equalization. Adequate pipe supports can reduce piping stresses .Evaluate the use of parallel slide gate valves which are not subject to thermal binding. However it is important to consider that they are more susceptible to pressure locking, higher seat wear as well as difficulties in positive sealing at low pressure

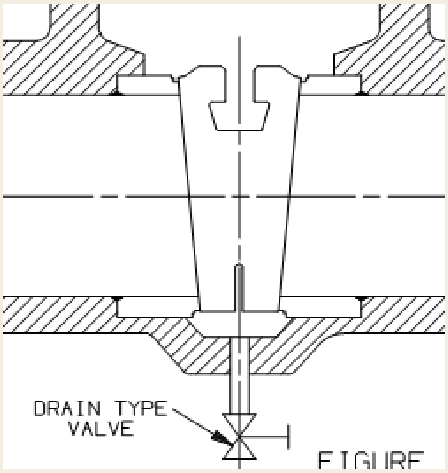

Figure 11
Drain type relief valve

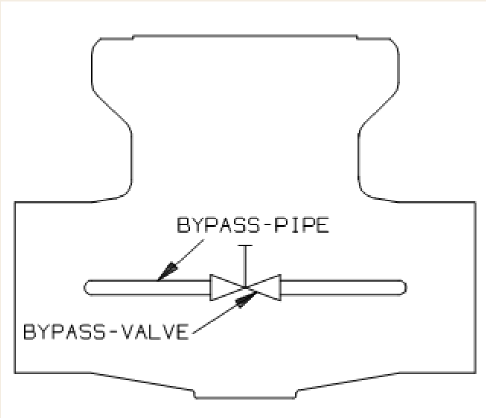

Figure 12

SOLUTIONS FOR COMBINED EFFECT:

When evaluation determines that thermal binding may exist in combination with over pressurization and /or pressure locking, the solution will require combination of both equalizing and bypass pipe/valve. See figure 13, 14 and 15, the particular choice will depend
on actual process, as well as requirements for bi-directional

RECOMMENDATION

Figure no 14 is the best solution to solve the problem of the combined effect of the thermal binding and over pressurization and also with this figure the valve will seal in both directions.

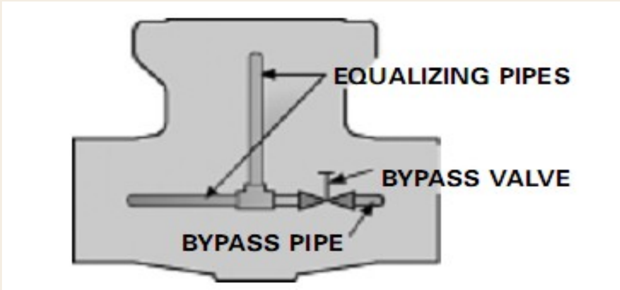

Figure 13

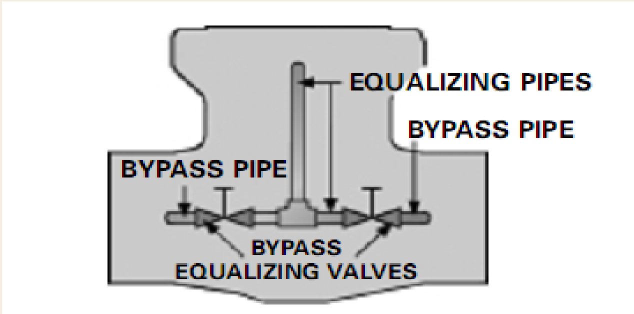

Figure 14
This figure is the best solution for the thermal binding and over pressurization

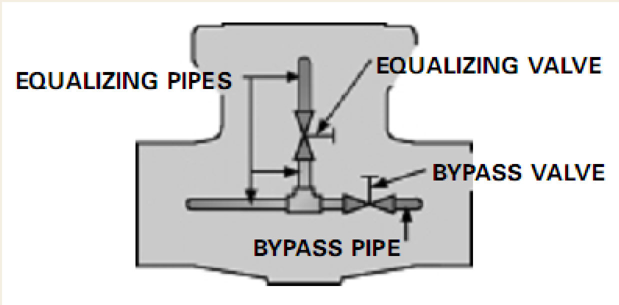

Figure 15

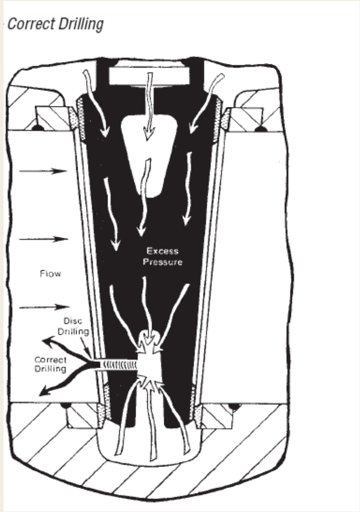

Figure 16
Correct drilling; the hole is connecting the valve caviy to the high pressure side

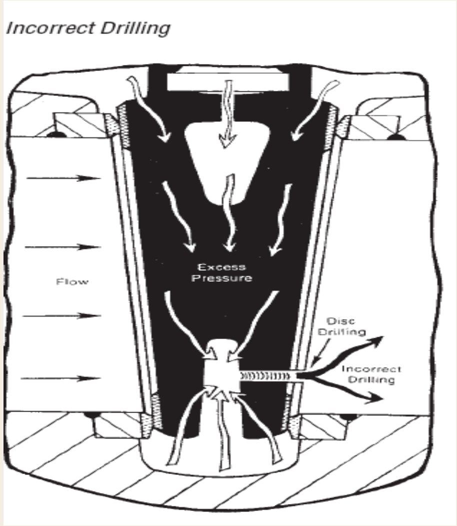

Figure 17
Incorrect drilling, the hole is connecting the valve cavi ty to the low pressure side

Biography:

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Employee Performance Appraisal

The (Un) Suitability of Management by Objectives Vs Management by Projects

Abstract

Organizations employ people for their work contributions, but there is no consensus as to how employees should be appraised. This paper investigates the use of Management by projects (MBP) versus Management by Objectives (MBO) and Key Result Areas (KRAs) as a basis for performance evaluation. It finds that almost all organizations use work achievements and a significant number appear to use an MBO approach as well. However, it appears that the MBO type approach as practiced by some organizations is flawed and that MBO is in general not appropriate for individual employees. The use of KRA based targets across all functions and levels is also not recommended. Instead a comprehensive framework to determine appraisal criteria is suggested. This paper is relevant to all enterprises that carry out performance appraisals.

Introduction

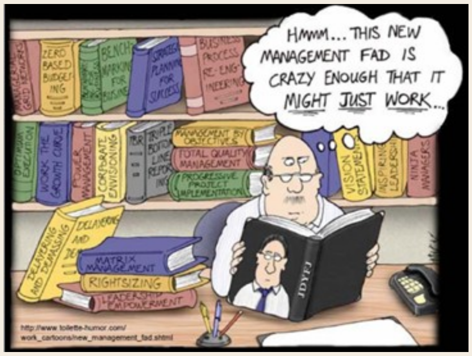
Performance appraisal is the activity concerned with determining the contributions of individuals to the organizations they are associated with and is present in all enterprises where employees report to superiors, irrespective of industry, function or level. However there is considerable debate, as yet unsettled, as to how employees should be appraised. Various researchers (Aldakhilallah and Parente, 2002; Asopa and Beye, 1997; and Cardy, 2004) have discussed this point and concluded that essentially three approaches to performance appraisal are possible. The results focused approach is concerned with whether the job has been done or not. Employees are rewarded for meeting or exceeding performance targets. The behavioral method is concerned with employee behavior. The focus is on whether an employee is doing things in the right way, and not on the amount of output as such. The advantage this approach has is that it becomes relatively to analyze and identify where a person is going wrong and to suggest steps to correct the same. This takes us away of concept called “Go Error”.

Finally, the person-centered approach is concerned with measures of personal characteristics such as knowledge, skills and ability. Employees are rated higher based on whether they possess the characteristics that are deemed to be superior. A high rating may be given to an individual for possessing formal qualifications or being certified as competent regardless of actual performance, or contribution to group efforts.

The earliest appraisals were trait based. Gradually, thereafter organizations turned to the appraisal of performance and behaviors. One of the major influences that swayed opinions in this direction was the work of Peter Drucker (Drucker, 1955) postulating the theory of Management by Objectives (MBO).

Another was a criticism of performance appraisal, by Douglas McGregor (McGregor, 1962) with its celebrated comment that ‘managers don’t like “playing God”’. McGregor argued that managers were reluctant to appraise and even more reluctant to product appraisal interviews because, among other things, they lacked the skill and doubted the validity of the appraisal instrument. The focus of McGregor’s disapproval was the use of traits for appraisal. His solution was to suggest appraisal of performance based on Drucker’s concept of MBO, by which performance would be measured against goals set by the employees themselves. While work output had perhaps been a factor in performance appraisal earlier, the theory of MBO propounded by Drucker (1955) remains till date one of the main intellectual inspirations for the use of performance as the appraisal criterion. Drucker advocated the use of objectives as performance standards. Unit managers were expected to participate in the process and help to set their own goals. In theory, organizations would develop a cascading system of objectives linking units to the organization. The contributions of the units would therefore directly reflect on achievement of organizational objectives. Now Management by Projects concept has appeared as a solution to how the employees.

In the marketplace of ideas, MBP is a direct competitor to MBO - the prevailing style of organizational management for over 50 years. MBP is relatively new, but it is a very potent improvement over MBO. That's why it is believed that MBP is the next great frontier of organizational leadership and organizational management - if we can give MBP a strong foundation. This article defines MBP in a new way, so that it is more competitive with MBO. This article also shows how MBP can benefit from the "radically simple" implementation of Earned Value Management (EVM).



What is Management by Objectives “MBO”?

Management by Objectives is a "technique used to manage people based on documented work statements mutually agreed by the manager and the employee. Progress is periodically reviewed, and in a proper implementation, the employee's remuneration is tied to performance.”

MBO “is the prevailing style of management in most organizations” and “it entails giving employees’ goals/targets, measuring their performance against these targets, and then ranking them against their peers or some other performance appraisal system. Usually, employees are rewarded or sanctioned based upon the outcome of this process.”

The Case against MBO

In 2004, Joseph F. Castellano wrote a compelling paper that demonstrates how MBO can directly lead to unhealthy internal competition, unethical behavior, and a work environment of fear and greed. Castellano relates several MBO examples, including the story of one his graduate students who worked for a lending company where loan officers were given monthly targets.

These targets contributed to an environment of intense competition among the loan officers because awards were given to the topper forming employee. Fear for one's job was also a by-product of this process. If an employee did not make his/her numbers, it was viewed solely as the loan officer's fault. Usually one or two loan officers consistently came out on top. The student indicated this was probably the case because they were the most knowledgeable and best trained. But he also pointed out that they were not about to reveal their secrets to the other loan officers because of the competition among them.

Leaders, who cultivate a healthy management style, including knowledge sharing, coordinated teamwork and systems thinking, may find that MBO unravels their good work. Why? Employees working under MBO may resort to self-centered conduct that is not in the best interest of clients or the organization as a whole. Since MBO rewards or sanctions individuals, it tends to assume that performance is based on special causes (individual performance issues) instead of common causes that are beyond the control of individuals. Setting pre-defined targets also ignores a principle of the Knowledge Age - that knowledge workers with deep local knowledge are more qualified to decide

"what is the task?" (i.e. knowledge-worker productivity).

While Castellano's paper presents a persuasive argument regarding the flaws of MBO, the paper only scratched the surface with regard to MBO-alternatives.

Certainly organizations want good results. The question is now going to become: By what methods? CULTIVATE COOPERATION, NOT COMPETITION. Good people in a good environment do good work. If we accept this premise, then the real role of top management is to create an organizational *climate* where people can join together to accomplish some noble purpose.

A Better Starting Line: What's Your Shared Purpose

Instead of describing the history and current state of MBP as a management approach; let's extend Castellano's line of thinking. By which methods will organizations achieve good results, if not through MBO? The answer is MBP if -- and only if -- we give MBP a new improved definition that begins with a new MBP mindset. Figure 1, below illustrates the recommended new MBP mindset. It begins with a deep understanding of what Castellano calls "joining together to accomplish some noble purpose." For simplicity, let’s call this as your "shared purpose." Notice that this mindset does not require individual work statements with numerical performance targets like MBO.

Albert Einstein had a sign in his Princeton office that stated "Not everything that counts can be counted, and not everything that can be counted counts." Your organization's shared purpose certainly counts, but it might not be countable. The shared mission of PGESCo for instance is "to maintain the trust and relation with our current customers." It isn't "to maintain 5% trust and relation with our current customers this quarter." Pursuing a shared purpose is a delightful alternative for those who have struggled to create Specific, Measurable, Achievable, Realistic, and Time-specific (SMART) numerical targets for every employee. Too often, MBO morphs into internal gamesmanship. It doesn’t mean that SMART objectives are always bad. But MBO tends to focus attention on internal supervisor-subordinate relationships, instead of promoting an external view of who the organization serves, what the whole organization must accomplish, why and how. MBO is a numerical forms of "management by org chart" - a relic of the Industrial Age. Now MBP focuses on shared performance, not individual performers. It is an approach suited for the Knowledge Age.

Outcomes and Actions / MBO and MBP Differences

A crucial difference between MBO and MBP is that objectives are defined in terms of project-focused outcomes, not by numerical targets for organizational functions and individuals. This crucial difference goes a long way toward replacing the internal competition and gamesmanship problems that Castellano has identified, and replacing them with collaboration, cooperation, and coordination. In the New MBP Mindset illustration (Figure 1) the large blue arrow between Shared Purpose and Discrete Outcomes is a scope definition (decomposition) process. It is a Project Manager “PM” skills. Talented project managers are good at translating a broad purpose into a hierarchical set of outcomes that are realistically scoped and suitably detailed to fulfill that purpose. In other words, scope decomposition process is a valuable PM skill that is needed at all levels of leadership, where it’s largely unrecognized outside of the PM community. Exactly, what is PM skill? A set of outcomes (e.g., elements of work breakdown structure) should always be comprehensive and mutually-exclusive. There should be no gaps and no overlaps in the scope definition. A poorly-scoped operations group is as detrimental to the organization as a poorly-scoped project. So, scope definition is a valuable PM skill set that goes hand-in-glove with the New MBP Mindset illustrated in Figure 1.The small blue arrow between Discrete Outcomes and Discrete Actions also represents an important skill set. However, the translation from discrete intended outcomes to front-line daily action is not just a project manager skill; it is a project team skill because ultimately the actions of all team members will achieve the discrete outcomes that fulfill the shared purpose.

So the two blue arrows are the "project analysis" processes. Analysis means scope is elaborated (decomposed) into progressively more granular parts. The two green arrows are "project synthesis" processes, where the whole endeavor becomes greater than the sum of the project's discrete parts. With MBP, these complementary but opposite processes provide a very direct link between a shared purposes to daily front-line actions. This direct line-of sight is one reason that MBP is an excellent competitor to MBO. With MBO, the line-of -sight between the organization's purpose and each individual's targets is usually not as direct or as clear.

What is MBP?

With this mindset in place, we can now define Management by Project (MBP) in a new way:

MBP is "fulfilling a shared purpose by completing discrete actions that are focused on discrete outcomes."

Figure 1: A New MBP Mindset

MBP Skill Set: A New Role for EVM

Earned Value Management EVM is an excellent skill set for implementing MBP. Despite that this runs against the grain of classic EVM textbooks that declare EVM is only for project work and not for operations activities; however, we're not talking about employing classic EVM. We're talking about simple assignments of Planned Value PV and simple earnings of EV for one purpose: to plan your work and work your plan. More advanced EVM topics, such as forecasting cost and schedule performance, can be reserved for larger (classic) projects that have disciplined budgeting and accounting processes.

To manage discrete outcomes, we assign PV to clearly delineate in scope work from out-of-scope work. If work priorities must change (which is common in knowledge work), then the allocation of PV must be changed accordingly. That's part of the change control process of MBP, and another classic PM skill. The valuable benefit of EVM is that the workforce should learn to trust PV assignments and EV earnings to focus their actions on *top priorities* where the employees performance is evaluated.

Finally

MBP can be applied to your current circle of influence, no matter how large or small. If you are the leader of a small group, you can use the New MBP Mindset (Figure 1) to create a direct line-of-sight from your group's shared purpose to daily actions of your team. If you are an entry level employee and your circle of influence is currently no larger than your cubicle, you can still employ the New MBP Mindset to improve your own project focus, and to expand your circle of influence. Don't start at the top; start within your current circle of influence.

Since MBP objectives are defined in terms of project-focused outcomes, not by numerical targets for organizational functions and individuals, therefore the employees appraisal should be evaluated in a typical way where for the project to achieve its objectives is a priority not only for the company/enterprise but the employee.Last but not least, some ways to sharpen your MBP skills directly affecting the employee appraisal will be addressed in another article thru the coming release of PGESCo newsletter. The next article main points are going to show how to stop managing "activities!", Quantify discrete outcomes, Quantify discrete actions and Drop MBO targets in favor of quantified outcomes and quantified actions.

Biography:

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Happy New Year

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