- Thermowells shall be machined from barstock
- Thermowells with specially designed surface structures are outside the scope of this standard
- Thermowells fabricated by welding at any place along the length of the shank or at the tip of thermowell are outside the scope of this standard
- Surface finish should be 0.81µm (32µin.) Ra or better as stress limits mentioned in the standard are not valid for rougher surfaces
- Thermowell dimensions shall fall within the dimensional limits specified in the standard for different thermowell shapes
- Use of support collars is not allowed

Any deviations from above stated points may change critical attributes such as natural frequency, damping, material properties or surface finish. These changes are difficult to account for in the calculations and lead to installation of wrongly designed thermowells.

<u>Understanding the 2016 version minutely</u>

What is not covered in standard?

- Thermowell manufactured from pipe is outside the scope of standard
- Thermowell with specially designed surface structure like Scruton/spiral design is outside the scope of this standard
- Excitation by incoherent structure born vibration by broadband and high frequency turbulence is a possibility and should also be considered. This type of excitation is determined by the design and support of entire piping system
- Flow induced vibration on array of thermowell installed closely together
- Thermowell failure arising due to pulsed flow induced vibrations

Expectations from a thermowell design and problems in getting an optimized one

Proper design of thermowell requires that sensor mounted inside thermowell shallattain thermal equilibrium with the process fluid.

A thermowell in high fluid velocity requires high natural frequency and low oscillatory stresses.

High natural frequency is obtained through:

- Decreasing the unsupported length (U)
- Decreasing the tip diameter (B)
- Increasing the support plane diameter (B) or root diameter (A)

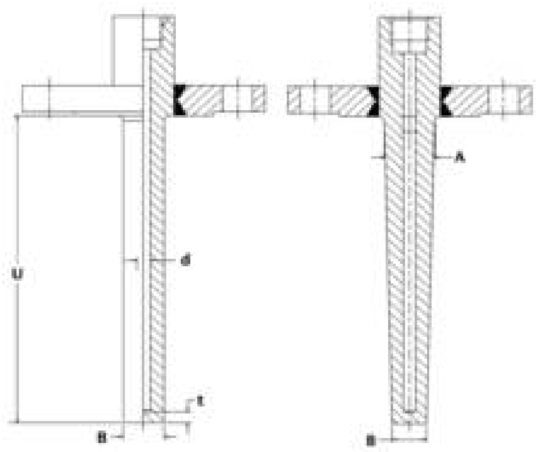

Figure 1. Basic thermowell dimensions

Lower oscillatory stresses are obtained through:

- Decreasing the unsupported length (U)
- Increasing the support plane diameter (A) and tip diameter (B)

For higher static pressure rating the tip diameter should be increased.

In contrast, good thermal performance favors increasing the unsupported length and decreasing support plane diameter and tip diameter.

All these thermowell dimensional parameters should be selected in such a manner that neither the thermal performance nor its mechanical strength gets compromised.

Pre-start-up conditions such as steam blows for pipe clean out shall also be considered. In the case of high pressure steam blows, the fluid velocities can greatly exceed 100 m/s (300 ft./sec), and thermowells shall be designed for these conditions also.

What a thermowell needs to withstand?
Static pressure stress, steady state fluid impingement, turbulence and dynamic excitation due to von Karman vortices.

As per the standard, there are four quantitative criteria that a thermowell shall meet to be fit for service.

1. **Static stress limit**: The maximum steady-state stress shall not exceed the allowable stress as determined by the von Mises criteria.

   The thermowell is said to pass the steady state stress criterion when the steady state drag stress doesn't exceed the von Mises stress.

2. **Dynamic stress limit:** The maximum primary dynamic stress arises due to flow induced turbulence and dynamic excitation from von Karman vortices shall not exceed the allowable fatigue stress limit.

3. **Hydrostatic pressure limit**: The external pressure shall not exceed the pressure ratings of the thermowell tip, shank and flange.

4. **Frequency limit**: The resonance frequency of the thermowell shall be sufficiently high so that destructive oscillations are not excited by the fluid flow.

The flow-induced stresses are modelled as distributed force acting on a flexible beam. The total force on the beam is proportional to the projected area of the thermowell normal to the direction of flow. Flow induced stresses are in form of longitudinal bending stresses. These are greatest at the support plane or root area of the thermowell.
Fluid forces acting on the thermowell in the flow direction are known as **drag/inline forces**and those acting in transverse direction are known as **lift/transverse forces**.

Figure 2. Fluid induced forces and assignment of axis for calculation of stresses [1]

Total force acting on thermowell is sum of steady state drag forces, oscillatory drag forces and oscillatory lift forces.

$F(t) = [F_D + F_d \sin(2\omega_s t)]$ in y-direction + $F_l \cos(\omega_s t)$ in x-direction
Where $f_s = \omega_s/2\pi$ is the Strouhal frequency.

The shedding of vortexes by a thermowell, subject to transverse fluid flow produces a periodic force on the thermowell. The frequency of vortex shedding, f_s, is related to the fluid velocity by dimensional less Strouhal number, N_s:

$$f_S = \frac{\omega_S}{2\pi} = N_S \frac{V}{B}$$

Where B = tip of the thermowell and N_s being a function of Reynolds number.

The natural frequency (f_n) of transverse vibrations of a thermowell mounted to a support is a function of

a) Elastic properties of the thermowell
b) Mass per unit length
c) Shear and rotational inertia at small values of L/A
d) Support compliance
e) Added mass of the fluid
f) Added mass of the sensor

The support compliance factors a significant reduction in natural frequency that results in flexibility of the thermowell mount or support. For thermowells installed in thin-wall pipes with outer connection heads, the mass of the head will cause a reductionin the required resonance frequency of the thermowell.

As the fluid velocity is increased, the rate of vortex shedding increases linearly while the magnitude of the forcesincreases with the square of the fluid velocity. The thermowell responds elastically according to the force distributionand its variation in time. When the vortex shedding rate coincide with the natural frequency of the thermowell,resonance occurs and is attended with a dramatic increase in the dynamic bending stresses. The fluid velocity atwhich this takes place is referred to as a velocity critical.

There are a minimum of two velocity criticals for eachnatural frequency of the thermowell, one describing the lift and the other describing the inline response. Since the in-line force fluctuates at twice the frequency of the lift excitation, the corresponding velocity criticalis approximately one-half of whatis required for lift resonance.

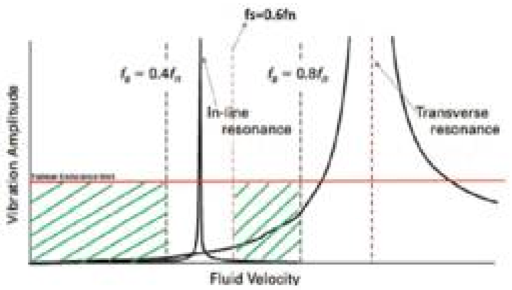

Figure 3. Amplitude response of thermowell subjected to fluid induced forces for inline and transverse excitations [1]

As the beam responds, the vortex shedding rate tends to settle onto the resonant frequency ofthe beam and remains locked in for a considerable range of fluid velocities. Thenatural frequency of thermowells may be as high as several thousand hertz; together with the lock-in phenomenon,it is possible for a thermowell to encounter many thousands of fatigue cycles in a single start-up process, even ifthe vortex shedding rate does not coincide with the natural frequency of the thermowell during steady-state processconditions.

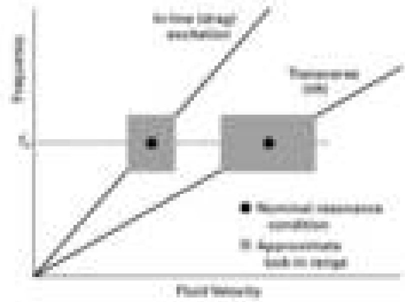

Figure 4. Schematic indicating excitation of resonances when excitation frequency coincides with the thermowell natural frequency [1]

To prevent the occurrence of lock-in phenomena and to limit the build-up of vibration amplitudes to a safe value,the resonant frequency of the installed thermowell shall be sufficiently higher than either the in-line or the transverseresonance condition.Operation of the thermowell through the in-line resonance is allowed only if the cyclic stressesat the resonance condition are acceptably small.

Frequency limit for low density gases

Fluids with sufficiently low density and $Re<10^5$, the intrinsic dampening of thermowell suppresses the in-line vibrations due to vortex shedding.

If mass dampening factor or Scruton number is less than 2.5 and $Re<10^5$, inline resonance is suppressed and following condition shall apply:

$$\frac{f_s}{f_n} < 0.8$$

If $N_{sc}>64$ and $Re<10^5$, then both inline and transverse resonance are suppressed.

If$N_{sc}<=2.5$ or $Re>=10^5$, the following limits shall apply:

- If thermowell passes cyclic stress condition then

$$\frac{f_s}{f_n} < 0.8$$

- If thermowell doesn't pass the cyclic stress condition, then

$$\frac{f_s}{f_n} < 0.4$$

Frequency limit when in-line resonance does not limit operation

In cases where the thermowell passes the cyclic stress condition for operation at the in-line resonance condition, care shall still be taken that in steady state the flow condition will not coincide with the thermowell resonance. Dwelling within the inline resonance region may cause a severe vibration of the thermowell tip. This could result in fatigue-related failure to the thermowell or unacceptable sensor damage or drift. To avoid this, the steady-state fluid velocity should meet one of the following conditions:

$$\frac{f_s}{f_n} < 0.4 \quad or \quad 0.6 < \frac{f_s}{f_n} < 0.8$$

Can thermowell be installed when inline resonance doesn't meet the cyclicstress conditions?

Yes, it can be installed if it follows the conditions stated in the standard like that the process fluid is to be gaseous, the thermowell is exposed to in-line resonance condition only on start-up/shutdown and others.

But use of thermowells in this condition should be avoided as it can damage the sensor.

Standard requirement given by ASME B40.200

ASME Standard B40.200, section 40.9, discusses the selection, fabrication and installation of thermowell, additionally providing details about standard design.

ASME Standard B40.200 also states that the standard bore diameters ("d" dimension shown in Figure 1) are 0.260 in. and 0.385 in. to accommodate¼ in. and 3/8 in. diameter sensors.

Conclusion

When a thermowell calculation does not pass the wake frequency test, the non-linear equations of ASME PTC 19.3 TW-2016 makes it difficult to find an easy way out by changing the thermowell dimensions. In general, shortening the thermowell to reduce unsupported length and increasing the thickness of thermowell (tip and root diameter) gives better result, but both the changes may have an adverse effect on the response time of temperature measurement. While shortening the thermowell unsupported length to pass the calculations, the thermowell shall comply the minimum immersion length requirement stated in API 551 [3].

Literature Cited

1. ASME PTC 19.3 TW-2016 Thermowells Performance Test Codes
2. ASME B40.200- Thermometers, Direct Reading and Remote Reading
3. API 551 Second edition, 2016 - Process Measurement

Security of COTS

Neeraj Agrawal,
Associate Director (Control & Instr.)
Nuclear Power Corporation of India Limited, Mumbai

Presented in PPA meet 2017, Delhi from April 21st -22nd, 2017

TOPICS COVERED

- What is COTS?
- The effect of cyber attacks
- What way COTS differs?
- Issues with COTS systems
- Risk with COTS systems
- How you can guard against cyber attacks?
- Cyber security for COTS systems- Good Practices

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What is COTS ?

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What is COTS?

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- Commercial Off The Shelf (COTS) product is commercially available software product- sold, leased, or licensed
- The necessary hardware and software are not designed to meet the specific requirements of a customer, rather they are generic in nature
- Source code is unavailable but adequate documentation is available
- Periodic releases with new features, upgrades for technology are common in COTS

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The effect of Cyber Attacks

The effect of Cyber Attacks

- System Modification
- Elevation of Access Privilege
- Denial of Service
- Proofing
- Invasion of Privacy
- Eavesdropping
- Antagonism

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What way COTS differs?

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What way COTS differs? (1/2)

Unlike custom build system where the system hardware and software are being made strictly as per the quality requirements of the purchaser and purchaser can apply quality check at each point of the development/manufacturing life cycle, COTS are purchased from third party where purchaser could apply very little or no quality control.

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What way COTS differs? (2/2)

- Each supplier have its unique security profile, its approach to risk management, its legacy equipment, financial capabilities, customer service priorities, and so forth.
- But the ultimate responsibility for the cyber security capabilities of the COTS, in most cases, rest with the purchaser.

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Issues with COTS systems

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Issues with COTS Systems (1/3)

- Generic nature of COTS Software
  - ✓ The developer of the COTS does not know where and how purchasers are going to use it, so the code will likely lack the specific features necessary to take advantage of purchaser's security infrastructure
- Undocumented features
  - ✓ A trivial example is an Athlon-XP processor built by AMD, where hacker found four undocumented Machine State Registers

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Issues with COTS Systems (2/3)

- Opacity
- Legacy software
- Supplier's priorities
- Availability
  - ✓ implication of the wide availability of COTS packages is; its vulnerabilities could be widely explored and shared as is the code to implement the attack

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Issues with COTS Systems (3/3)

- Popularity
  - ✓ Because of the widespread use of these products in everyday life, these systems are alluring criminals and numerous malicious programs are available to attack them
- Liability
  - ✓ COTS software vendors have very limited liability

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Risk with COTS systems

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Risk with COTS Systems (1/2)

(A) Vulnerability to security /Security holes

Vulnerabilities arise from

- Legacy Codes
- Extra functionalities
- Code Weakness
- Use of open system architecture
- Plug and play devices etc.

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Risk with COTS Systems (2/2)

(B) Threats

- Malicious code
- ✓Viruses, Worms, Spyware, Pre installed backdoor rootkit
- Riskware
- Gray ware

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How you can guard against cyber attacks?

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Identification & Categorization

- COTS can have one or more vulnerabilities that can be exploited by a threat agent(s). The result can potentially compromise the **integrity, availability or confidentiality** of the COTS system
- To decide over the commensurate countermeasures, it is imperative to identify and categorize COTS systems based on consequences of compromise of the systems

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Prevention

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Prevention (1/4)

- Incorporation of appropriate security features in the design, assessment of vender's cyber security plan & procedure and application of QA can effectively reduce the vulnerabilities in the systems which will prevent unauthorized users from accessing any part of computer system
  - ✓ Specification of top level security requirements at the SR level
    - unidirectional data flow, restriction on use of plug and play devices, access control, use of cryptography (Secured Socket Layer), use of tempest proof hardware, high-quality cables with special characteristics regarding physical shielding etc.

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Prevention (2/4)

- Product Specification Compliance and Fitness for Purpose
- Configuration requirement of hardware
- Customization requirement of software
- Hardening requirement of the platform
  - ✓ Disabling unneeded services and protocols, like NetBIOS or tftp, and restricting permissions of visitor accounts could further enhance security
- Application programming requirement
- Additional testing
- Independent Verification & Validation

Prevention (3/4)

- Collection of evidence from software vendors to ensure that their software development lifecycle addresses the security aspects.
- Request vendors about the process that they followed to ensure security of the components and services that they receive from their own suppliers to ascertain appropriate due diligence.
- Service Level Agreement (SLAs) and other contractual tools
  - ✓ They shall be properly leveraged to ensure that vendors and partners live up to their obligations.
  - ✓ For instance, if a breach occurs at a partner organization, details of the breach shall be notified to the purchaser at the earliest.

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Prevention (4/4)

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- Update
  - ✓ Ensure the latest security patches are applied to all the software running on your network host
- Secure change control and configuration management processes
- Periodic audit

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Protection

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Protection (1/2)

- Use of Firewall Program
- Use of Hardware Firewall
- Installation of antivirus software
- Data Encryption
  - ✓ Use strong encryption and ensure that cryptographic protection is not undermined through improper certificate or key management

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Protection (2/2)

- Enforcement “least privilege” access
  - ✓ Ensure that employees have only the privileges they need to perform their jobs
- Use of strong password
- Implementation of remote attestation techniques for your field devices
- Backups of important files and folders

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Detection

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Detection (1/2)

- Detection helps you to determine whether or not someone attempted to break into your system and what damage they may have inflicted, had they become successful.
- With well defined set of allowed services, and their strict implementation it is possible that links between systems and servers can be monitored and controlled reliably

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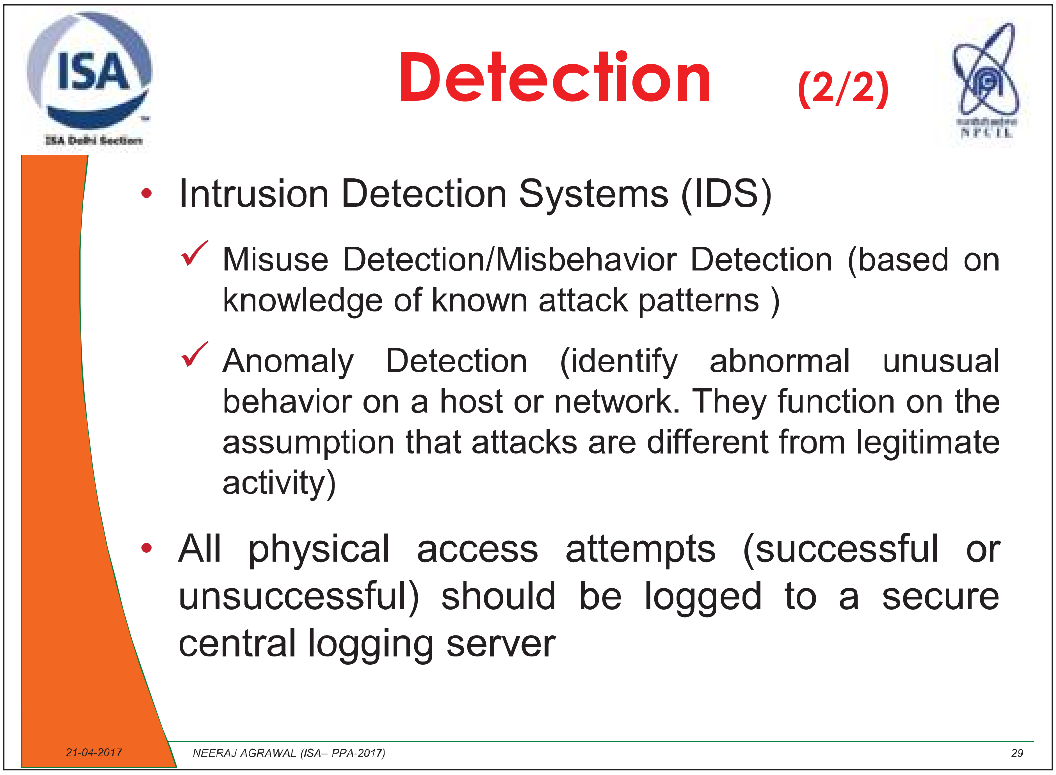
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Detection (2/2)
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• Intrusion Detection Systems (IDS)
✓ Misuse Detection/Misbehavior Detection (based on knowledge of known attack patterns)
✓ Anomaly Detection (identify abnormal unusual behavior on a host or network. They function on the assumption that attacks are different from legitimate activity)
• All physical access attempts (successful or unsuccessful) should be logged to a secure central logging server
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Reaction
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Reaction

- Recovery
  - ✓ System security plan shall cover the counter measures including the recovery procedure in case of loss of systems due to security related incident
- Restore from the backup
- Reset to factory setting and reconfiguration

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Training

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Training

- Establish a security awareness program
  - ✓ Ensure that all personnel have an understanding of sensitive systems /information and common security risks, and basic steps to prevent security breaches
- Train employees who have access to CDA
  - ✓ Build operational awareness of threats and vulnerabilities, allowing the organization to address high-priority items
  - ✓ Ensure that employees who have electronic or physical access to critical assets know how to handle the assets securely and how to respond and whom to report cyber security incidents

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Cyber Security for COTS Systems – Good Practices

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Product Evaluation Level (1/3)

- Stand alone systems
  - ✓ All COTS Systems are stand alone systems sharing no data link with other systems .Systems (CDA) are being categorized to "High". "Medium" and Low" based on the impact of the compromise on plant Safety, Security, Safeguard and Emergency preparedness
- Access through Secure Means (passwords/ biometric)
- Role based access control
- Indication / annunciation/log of security breach
- Hardening requirements

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Product Evaluation Level (2/3)

- Existence of extra functionality in the COTS and its impact on the rest of the system
- Requirements for the addition of functionality via glueware because the COTS doesn't provide all of it
- Items/features not complied by the vendor
- Existence of approved deviation report

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Product Evaluation Level (3/3)

- Availability and accessibility of documents w.r.t. the development process to establish equivalence to that required for SRRP
- Technical support from Vendor for complementary qualification
- The frequency of bug fixes or upgrades release
- Information regarding availability of modified/ upgraded version release

Configuration management (O&M) Level

- Policy and procedure for installation of new version of software
  - ✓ Certification from IVVC
  - ✓ Site validation
  - ✓ Update documentation
- Policy & procedure for changing of passwords under following heads
  - ✓ User Password
  - ✓ System Password
  - ✓ Administrator Password

System Customization Level

- Identification of Customization, Configuration (software and hardware) requirements
- The need for additional software (glueware) to be developed to connect it to /implement it for CBS under consideration
- Configuration management Plan and Procedure for customization/configuration
- Extra analyses and tests needed to be performed to verify the COTS

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Verification & Validation

- As per Relevant Standards and Company Policy

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Electricity Generation by Bicycle And Its Use In Villages To Overcome Health Diseases

Abhishek Matlotia
EEE, 4th Year
BVCOE, Delhi

Ajay Kumar
EEE, 4th Year
BVCOE, Delhi

Abstract— Electricity is the basic need of human beings. But not everyone can afford it. There are many people in India who are still not connected to electricity; most of them belonging to the rural areas. The bicycle generator can serve for the requirements of electricity of the people at nearly no cost. The bicycle generator will produce electricity in D.C. form. Inverter circuit will be used to power electrical equipments. Also, the cooking methods used in rural area till now are still the traditional ones, which cause a lot of respiratory diseases among the people. Presently, majority of the rural India still has to feed on firewood for fuel requirement which in turn cause a serious impact on their health. Thus, the electricity generated can be used to overcome the health diseases and also to support other electrical appliances. The electricity generated would be stored in rechargeable batteries and consumed when required. The overall efficiency of the system is increased with the help of an economizer and feedback system. Thus the problem of electricity as well as health diseases is solved.

Key words- bicycle generator, cooking methods, respiratory diseases.

I. INTRODUCTION

In India, many people living in villages do not have electricity at homes and the ones who do, suffer 12-15 hours of power cut. There are more than eleven lakh homes in rural India which do not have electricity. In this growing technological age, electricity is the basic need. People have enough physical strength and thus can generate electricity themselves too. The device functions in a way that the physical strength of the people is converted to mechanical energy and is further converted into electrical energy.

The mechanical energy is applied to the pedals of the bicycle. This energy is then converted into electrical energy using D.C. generator. The electricity is then stored in batteries so that it can be used to power various electronic equipments. Also, the power stored in batteries can be converted to A.C so that all the electrical equipments can be powered.

The cooking methods used by people in rural areas still employ the use of firewood as fuel [1]. The people cook food on traditional stoves called “chulhas”. Firewood when burned produces a lot of smoke and heat. This smoke can cause serious respiration problems. To solve this issue, a duct is placed over the chulha. The end of the duct opens to an exhaust fan which will be sucking all the smoke produced during burning of firewood while cooking.

Thus the electricity produced by human strength through pedaling can be used to protect the people from the smoke produced during cooking which will also give protection against chronic respiratory diseases, heart diseases and lung diseases.

II. BASIC DESIGN

The basic design for electricity generation involves; bicycle wheel, flywheel [2], D.C. generator, boost converter, D.C. batteries and D.C. to A.C. converter. The basic design for smoke free chulha involves; duct, exhaust fan, D.C. generator.

The bicycle wheel comes with a pedal so that people can easily put in their physical strengths onto it. The wheel is further connected to a D.C. generator through a belt. The belt is connected across the circumference of the wheel and shaft of the D.C. generator. When a person paddles, the wheel as well as the shaft rotates and hence electricity is generated. The electricity generated from D.C. generator is in form of D.C. This D.C. is stabilized and increased using boost converter and then stored in batteries for further use. For using electrical equipments the stored D.C. is converted to A.C. using the inverter circuit.

The smoke free chulha design is employed over the simple chulha which is used for cooking at houses. A duct is placed at the top of the chulha. The other end of the duct ends at the exhaust fan. The exhaust fan will suck all the smoke produced during cooking and hence will protect the person who is cooking, against the respiratory diseases.

III. BICYCLE GENERATOR

The bicycle generator will involve the use of the bicycle wheel, D.C. generator, boost converter and batteries to store electricity. To increase the overall efficiency of the system a flywheel can also be used, which will temporarily store the kinetic energy of the wheel [3].

The basic block diagram of the bicycle generator can be seen in fig. 1, the bicycle wheel and the shaft of the D.C. generator are connected through belts. So when the wheel rotates, the shaft of the D.C. generator also rotates. The flywheel can be connected to the same belt.

The basic principle of D.C. generator involves the Faraday's law of induction. The principle states that if a coil is rotating in a uniform magnetic field, a voltage will be induced at its terminals[4]. This voltage generated will be used to power the load. The magnitude of the voltage generated depends on the magnetic field strength as well as the speed of rotation.

Fig. 1 Block diagram of bicycle generator

The voltage generated by the bicycle generator is dependent on the speed of the rotation. So, there is a tendency of voltage fluctuations. To solve this problem a boost converter is used [5]. The voltage will be increased to the desired level when the voltage generated is low. Thus this maintains a stable voltage. The fig 2 explains the circuit diagram of the boost converter on Matlab simulink [6], the 5 volts output from the D.C. generator is given as input to the boost circuit. The fig. 3 shows the graph of output voltage with respect to time. The output voltage of boost converter is 22 volts. Thus, the 5 volts of D.C. generator is converter to 22 volts using boost circuit.

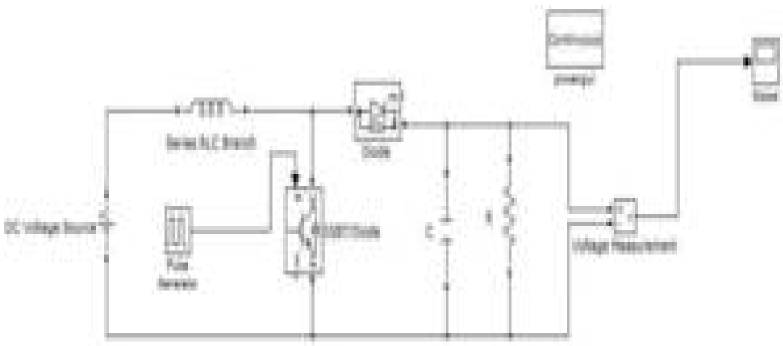

Fig. 2 Circuit diagram of boost circuit

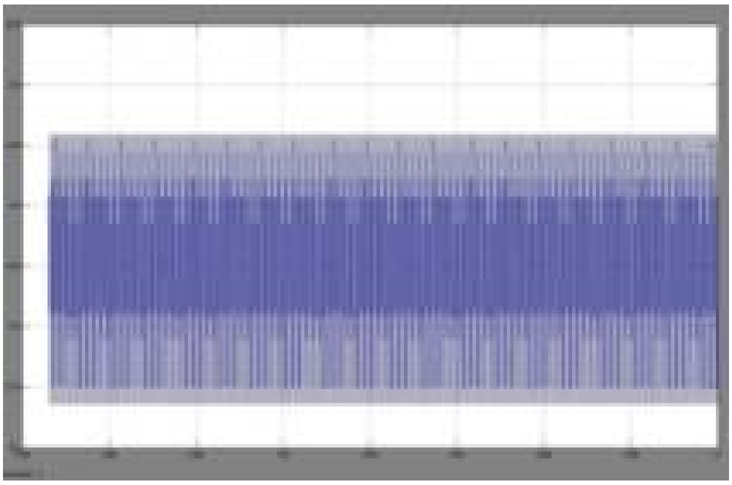

Fig. 3 Graph of output voltage w.r.t. time for boost circuit

The stable voltage from boost converter is then stored in D.C. batteries because D.C. can be stored easily. The voltage from the D.C. batteries can be used to power the electronic equipments. An additional D.C. to A.C. inverter circuit should be used to convert the D.C. into A.C. so that the electrical equipments can also be powered [7].

The fig. 4 explains the inverter circuit on Matlab simulink; the output D.C. voltage of 22volts from boost circuit is given as input to the inverter circuit. The fig. 5 shows the graph of output A.C. voltage with respect to time. Hence, 22volts D.C. is converted to 22volts A.C. using inverter circuit. This 22 volts A.C. can now be stepped up to 220 volts by a transformer of 1:10 turns ratio [8]. The electrical appliances can be easily powered by the 220 volts produced at the secondary of the transformer. The schematic diagram of the whole setup can be seen in fig. 6, the voltage values at different circuits have also been defined in the diagram.

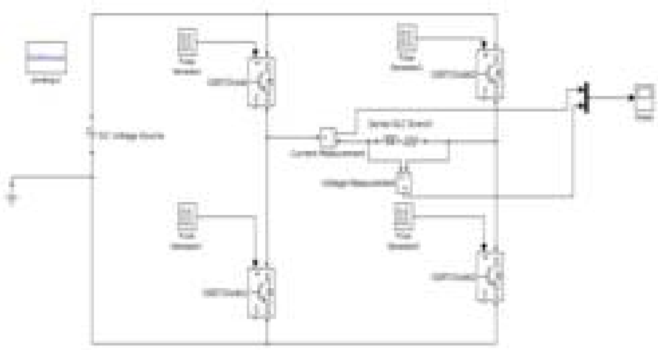

Fig. 4 Circuit diagram of inverter

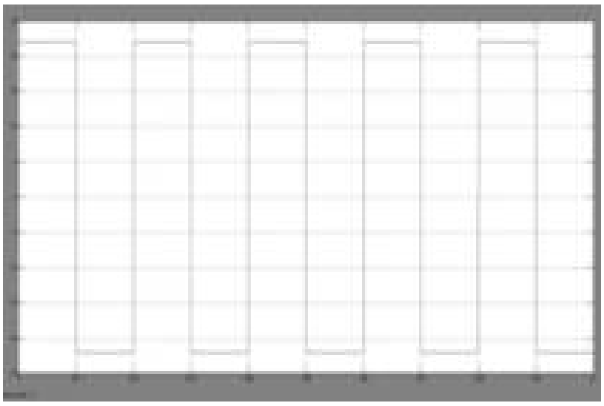

Fig. 5 Graph of output voltage for inverter circuit

Fig. 6 Schematic diagram of bicycle generator

IV. SMOKEFREE CHULHA

The chulhas that are used for cooking employ the use of firewood as fuel. More than eight five percentage of the rural population still uses firewood as fuel for cooking. Firewood burning produces a lot of smoke and heat [9]. So, to suck the smoke out of the chulha, an exhaust fan is used. The exhaust fan is connected to the chulha through duct.

Whenever there is a lot of smoke during cooking, person can simply switch on the exhaust fan. The exhaust fan is powered by the electricity generated by the bicycle generator.

To increase the efficiency of the system, a small D.C. generator can be used after the exhaust fan. The exhaust fan sucks the hot air from the duct and sends it outside [10]. The shaft of the D.C. generator can feed on the emission by the exhaust fan. A decent amount of electricity will be generated by the D.C. generator. The D.C. generator can then be connected to the buck-boost converter and used to store the electricity in D.C. batteries.

An economizer can also be used along the walls of the duct [11]. The walls of the duct will get hot due to the smoke that is passing through it. This heat can be used to warm the water. Hence, warm water is produced and no additional firewood is to be burnt to have warm water. Hence ultimately the person who is cooking is protected from various respiratory diseases.

The basic block diagram of the smoke free chulha is shown in fig. 7, chulha is connected to duct and the duct is further connected to the exhaust fan. The economizer and D.C. generator can also be seen in the diagram. Both of them help in increasing the efficiency of the system.

The fig. 8 shows the schematic diagram of smoke free chulha, input power of exhaust fan comes from the inverter circuit. The output generated by the D.C. generator is fed to the batteries.

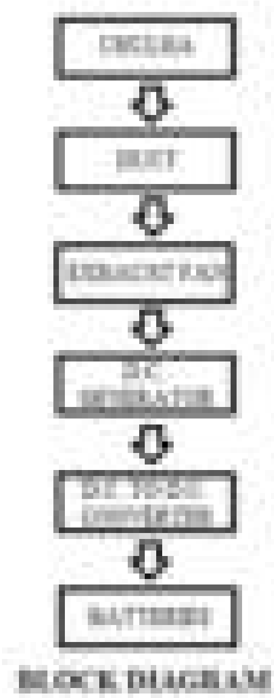

Fig. 7 Block diagram of smoke free chulha

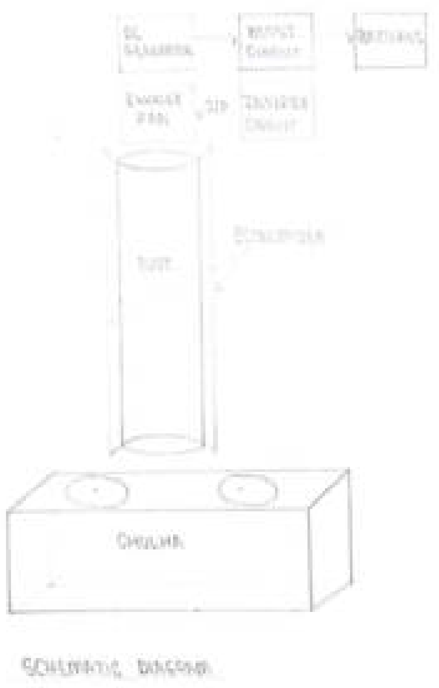

Fig. 8 Schematic diagram of smoke free chulha

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Presented by
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Mr. Rajat Goya

"Non-Integrated Method for Providing In-Line/ On-Line Instrument Dimensional Data to Piping"

Sheikh Rafik Manihar Ahmed*, M. Srinivas**, Luis Angelo Bonito***
*,**Control Systems Engineer, Fluor Daniel India Pvt. Ltd., New Delhi, India
***E&CS SmartPlant Lead, Fluor B.V., Amsterdam, Netherland

Abstract: Detailed In-line/ On-line instruments dimensional data play's pivotal role in the plant engineering design of highly schedule driven modular, skid-mounted, Offshore and nuclear projects. The problem of meticulously capturing dimensional data of In-line/ On-line instruments is compounded by lack of integration between instrumentation, 3D piping model software (SP3D) and corresponding work process to implement it. This paper explains the most effective Non-Integrated work flow of providing In-Line/ On-Line instrument dimensional data to piping in the very initial phase of the project, thereby improving efficiency of designing instrumentation in 3D piping modeling with accurate vendor data to eliminate piping rework. Non-Integrated (Non-SPF) Method of providing In-line/ On-line instruments dimensional data to piping is developed to address the challenges involving during exchange of vendor dimensional data between control systems and piping.

Keywords: *DDP- Dimensional Data for piping, SPI- SmartPlant Instrumentation, SPF-SmartPlant Foundation, SP3D- SmartPlant 3D, In-Line/ On-Line Instruments, Piping Isometric drawings.*

I. INTRODUCTION

The Dimensional Data for piping (DDP) Module is used to provide the detailed dimensional data of instruments to piping for 3D piping modeling. DDP Module allows us to store and maintain default instruments & dimensional data received from vendor. It provides us to the means to transfer, store, and maintain vendor dimensional data for in-line instruments. This vendor data will then be transferred to our working data, which we use for the actual instruments in our database. In-line/ On-line instrument dimensional data is managed in the SPI DDP module as DDP data sheets. Once DDP is available, dimensional data is published from SPI to SmartPlant instrumentation database and then this database can be used for external 3D piping design modeling. The SPI DDP Module enables us to use the imported dimensions to create dimensional data sheet for components. The SPI DDP Module enables separate storage & management of dimensional data received from vendor in three levels- preliminary, design, and certified data.

3D Modeling in SP3D or PDS is much easier and faster than DDP. The DDP supply consistent dimensional data to piping for modeling, which avoids costly rework on-site by ensuring correct fit of components and verified by piping 3D Model clashes checking and tracking of instruments becomes easier due to dimensional status code. Instrumentation is most voluminous design discipline and has more graphic design variation. The instrument DDP graphics comprises of all possible instrument types, positioner/ Handwheel/ Actuator orientations and rating & sizes details, weight.

II. INTEGRATED METHOD OF DDP

In Integrated or SPF Method of DDP, In-Line/ On-Line instruments dimensional data is managed in SPI DDP Module. By using SmartPlant Foundation (SPF), this transaction is integrated which means SPI can send its data directly to SP3D using its foundation. Once DDP is available, it is published from SmartPlant Instrument (SPI) into SmartPlant Foundation (SPF) and then retrieved into SmartPlant 3D (SP3D) as shown in figure.1.

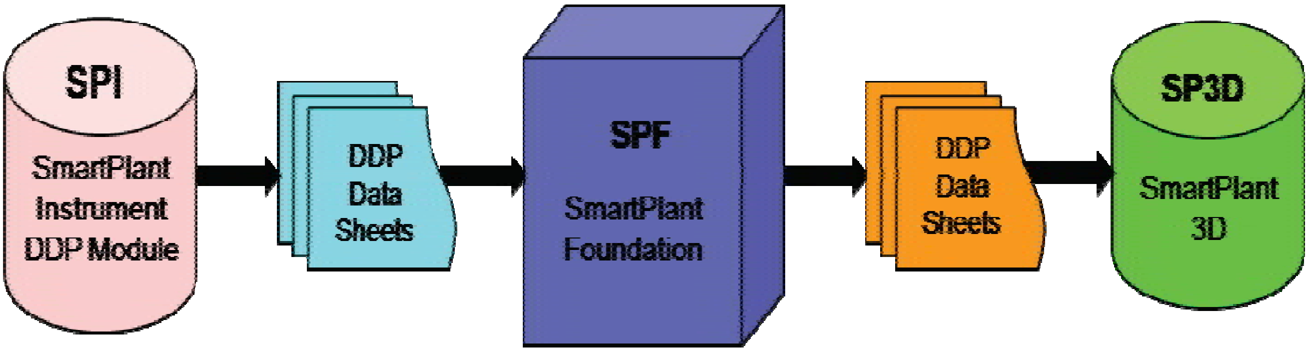

Figure.1: Diagram shows data flow from SPI to SP3D using Integrated Method.

A. Work Process for Integrated Method

The objective of this work process is to describe the proper work flow/ instruction on how to develop/ update DDP datasheets in SPI DDP Module, published it from SPI into SPF, and then retrieved into SP3D. The following steps are required for providing in-line/ on-line instrument dimensional data to piping as shown in figure.2 using SmartPlant Foundation or Integrated Method:

Step 1: ***Create DDP Data Sheets*** **–** Before creating DDP datasheets, Originator (Designer/ Engineer) has to check vendor drawing status and inline data revision to indicate status as preliminary, design and certified. Then select supported DDP groups as applicable to the instrument and prepare DDP datasheet for each tag numbered item in accordance with vendor drawing.

Step 2: ***Publish DDP Datasheets into SPF*** **–** After developing DDP dimensional data sheets for each tag numbered item in SPI DDP Module, Control system designer/ engineer should check DDP data with received vendor drawing and published DDP dimensional datasheets from SPI into SmartPlant Foundation (SPF). Even though, if any instrument tag is renamed or deleted or added after publishing DDP dimensional datasheet, it needs to be communicating with SP3D coordinator to retrieve the data from SPF into SP3D. User needs to have access of SPF login to revise/ publish document.

Step 3: ***Retrieved DDP Datasheets from SPF*** **–** The HOST SP3D Coordinator retrieves the newly published DDP dimensional datasheets into SP3D at the HOST Database. If the DDP Datasheets do not show available for retrieval, it indicates that the tags are not published into SPF and/ or the instrument tag is renamed or deleted in the SPI database. In this case, this is to be coordinate with concern control systems Designer/ Engineer to ensure it completeness.

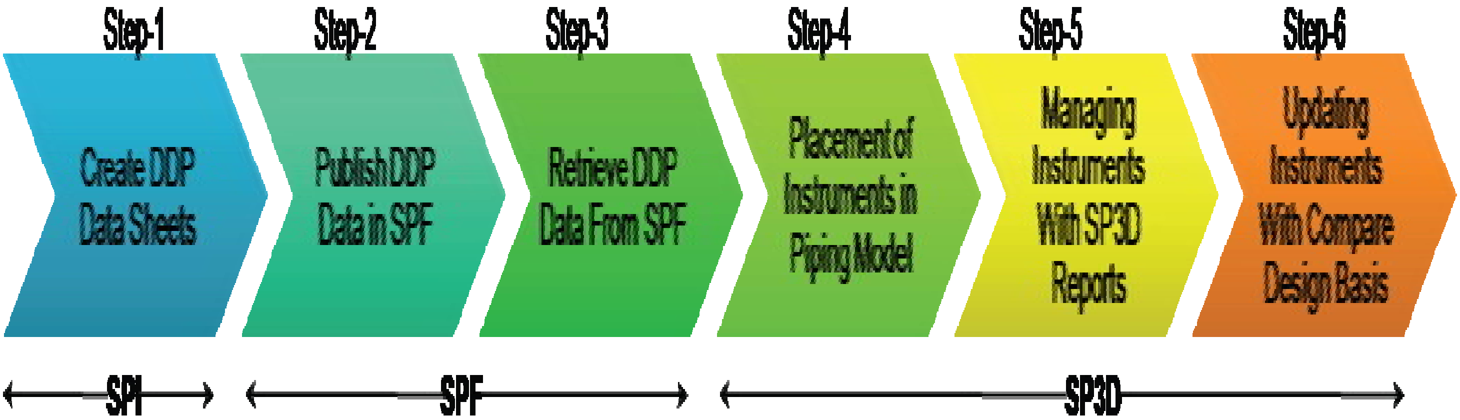

Figure.2: Diagram shows basic work process on how the dimensional data is transferred to 3D piping model using Integrated Model.

Step 4: ***Placements of Instruments in SP3D Model*** – After retrieving DDP dimensional data from SPF to SmartPlant 3D (SP3D) module, piping designer starts the placement of inline/ online instruments in piping 3D model from the retrieved DDP. During placement if any modification is required than comments should given to Control Systems to address the actual 3d model requirement. If the DDP is not available at the time the instrument needs to be placed, the piping designer can manually place an instrument item from SP3D catalog and assign it the tag name of the instrument. This will be a "Place-Holder" for the actual instrument to replace it once it is available. Design basis drop down is used to select the DDP and it completes the placement of Inline/ Online instruments from DDP into piping 3D Model.

Step 5: ***Managing Instruments with SP3D Reports*** – The Custom SP3D report is used to assist the engineers/ designers in managing the lists of all instruments with DDP that have been retrieved into SP3D and/ or manually created in SP3D from the SP3D catalog & assign it the tag name of the instrument. This manually created needs replacement with DDP instruments.

Step 6: ***Updating Instruments with compare Design Basis*** – "Compare Design Basis" is the command in SmartPlant menu, which is used to identify where the 3D model is in conflict or clashes with the latest retrieved design basis. Compare Design Basis allows piping designer to update the 3D Model promptly as per the latest retrieved dimensional datasheets into SP3D from SPF.

The following errors are observed in Integrated/ SPF Method, while placing In-Line/ On-Line instruments in piping 3D model:

1. Instruments are not retrieved into SP3D.
2. Changes in DDP datasheets are not publish/ retrieve into SP3D.
3. Rename instruments after published DDP documents to SP3D are not retrieved into SP3D.
4. Mismatch data for piping connection in SPI and SP3D.
5. "Blank" or "0" values left in DDP data sheet dimensional.
6. Incorrect End prep selection in SPI.

III. NON- INTEGRATED METHOD FOR DDP

In non-integrated/ Non-SPF method, the standard DDP dimensional status work procedure will not be used. This procedure is too cumbersome and doesn't have Cut & Paste function for mass update. Each item has to be set individually and takes around 5 mouse clicks to update. To overcome this problem, the last dimension field will be used to identify the status. All input forms are modified to show the status (Preliminary, Design, and certified dimensional data) in the last dimension field. In non-integrated method, the dimensional data has to be extracted in spreadsheet file and converted to make it SP3D compatible.

It was observed that the DDP suspect flag is not working anymore in non-integrated method and it doesn't indicate the change in dimensions of shape. The suspect flag was planned to flag changes in DDP for export to SP3D. We have developed another procedure to indicate the changes in dimension of shape in DDP.

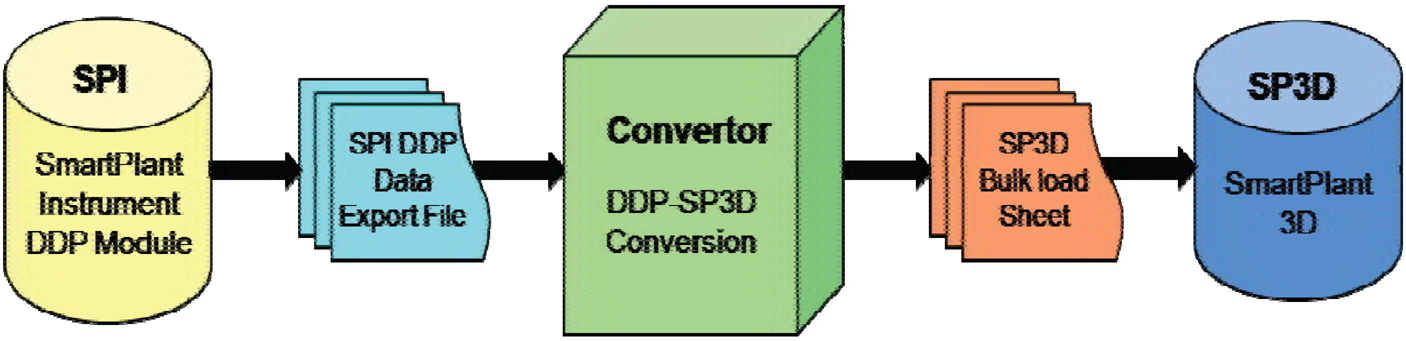

Figure.3: Diagram shows data flow from SPI to SP3D using Non-Integrated Method.

There are three levels of data available in Non-Integrated Method of DDP:

- <u>*Preliminary Dimensional Data*</u> – At the initial phase of the project, preliminary dimensional data is populated in SPI DDP Module, So that preliminary data can be utilized by piping as reference to hold the space for different voluminous instruments between pipes. Preliminary dimensional data is based on assumption by using vendor's catalog and/ or from standard dimensional data library.

- <u>*Design dimensional data*</u> – Design dimensional data is available, after releasing RFQ (request for quotation) datasheets, proper evaluation of vendor's bid and reviewing the detailed vendor's drawings. This design dimensional data is updated in the SPI DDP module and issued to piping as design dimensional data to optimize the plant model.

- <u>*Certified dimensional data*</u> – Certified dimensional data is available, after receiving post purchase order vendor certified dimensional drawing from approved vendor. This certified data is final dimensional data, which is to be used by piping as final data for their isometric drawing and fabrication of pipe spool piece.

A. Work Process for Non-Integrated Method

The objective of this work process is to describe the proper work flow/ instruction on how to develop/update DDP datasheets in SPI DDP module with three levels of data, extracted SPI DDP data export file in spreadsheet, converted it into SP3D compatible file, and then final Bulk load into SP3D Host database. The following steps are required for providing in-line/ on-line instrument dimensional data to piping as shown in figure.4 using Non-Integrated Method:

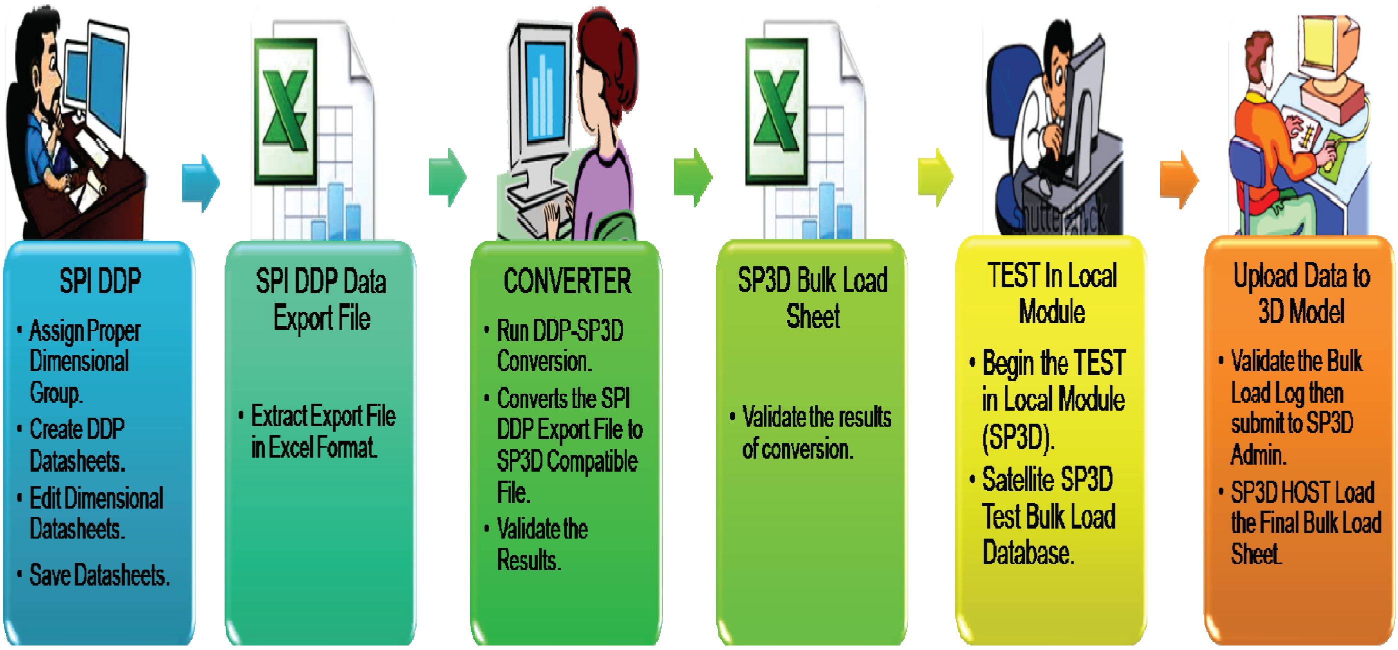

Figure.4: Diagram shows basic work process on how the dimensional data is transferred to 3D piping model using Non-Integrated Model.

Step 1: ***Create SPI DDP Data Sheets*** **–** Initially, automation team develop test model for verification of DDP symbol. After that Originator (Designer/ Engineer) has to check vendor drawing status and inline data revision to indicate status as preliminary, design and certified. Then assign proper DDP dimensional groups as applicable to the instrument and starts preparing DDP dimensional datasheet for each tag numbered item in accordance with vendor drawing.

Step 2: ***SPI DDP Data Export File*** – After developing DDP dimensional data sheets for each tag numbered item in SPI DDP Module, Control system designer/ engineer should check, review and edit the DDP dimensional datasheets with preliminary data available and extracts the SPI DDP data export file in excel format from SPI DDP Module.

Step 3: ***Converter*** **–** "Converter" is a program file, developed to convert the SPI DDP export file (excel format) to SP3D catalog load file (excel format). SPI-DDP Admin runs DDP-SP3D converter along with sample master file and generate final SPI bulk load sheet. Converter is a program file that creates SP3D catalog load sheet which can be directly loaded into a SP3D catalog. Base for the program, is a template file or sample master file used to bulk load stock instrument items into SP3D. In this convert program, SP3D code list mapping has been identified for each instrument or SP3D symbol. This program also keeps track of any new, revised or deleted instruments.

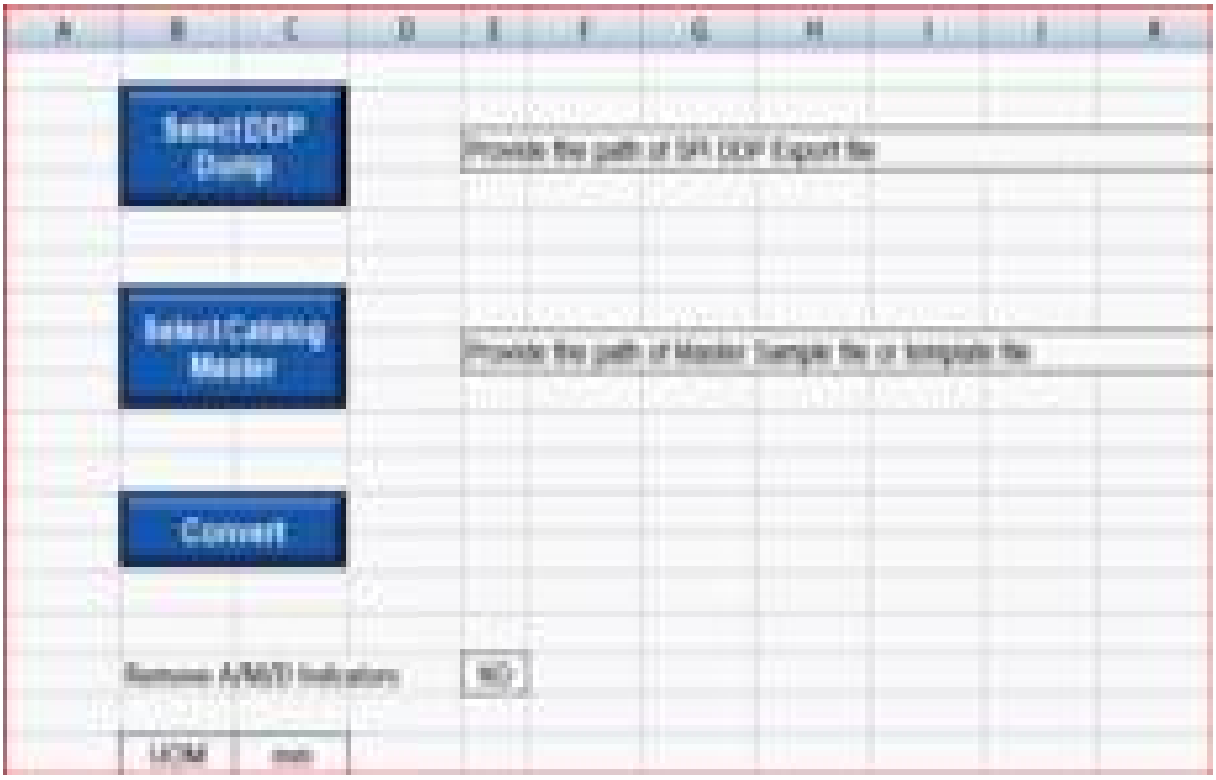

Figure.5: Diagram shows the Convert Program file.

The execution procedures of the convert program file are following as:

i. *Select DDP Dump Button* – This button is used to provide the path of latest file exported from SPI. If this button is selected, a file navigator dialog box will be opened. In this dialog box the correct file and file location can be selected.

ii. *Select Catalog Master Button* – This button is used to provide the path of Master SP3D catalog load file. This file comprised of all the instruments that have been loaded into SP3D catalog. This master template file is based on the SP3D standard catalog load file.

iii. *UOM* – This UOM tabular is used to set the unit of measurement in “inches or millimeter”. This is important because the symbol dimensions in DDP can be given in “Inch or mm” and can’t be imported from SPI DDP Module.

iv. *Remove A/M/D indicators* – This tabular can be set as “YES or NO”. If Remove A/M/D Indicators is set to “YES”, then only the program file will run and proper conversion is done. If Remove A/M/D Indicators is set to “No”, it means the file is opened and the convert button is selected the program will stop and show some default error.

v. *Convert Button* – This button is used to generate a new SP3D catalog bulk load file with file name "*AddModifyDelete-InstrumentData.xls*" in the master directory. This file will have all A, M, or D indicators assigned and needs be loaded in SP3D using the Bulk utility.

Step 4: *SPI Bulk Load Sheet* – After conversion, SPI-DDP Admin validates the results and send SP3D catalog load file for test in local test database module.

Step 5: *SP3D Test Bulk Load Database* – SPI DDP Admin uploads the SP3D bulk load sheet to satellite SP3D test bulk load database or catalog test project for test. After loading of bulk load sheet, designer/ engineers starts placing instrument in test model to check for inconsistencies and validate the bulk load log then inform to SP3D coordinator that the files are ready to be loaded in the production project.

Step 6: *Upload Data to 3D Model* –The HOST SP3D Coordinator starts uploading final bulk data to 3D model and after completion of loading of Bulk sheet in 3D model, Admin informs to piping and instrumentation. Then originator releases data for the verified and acceptable tags to piping along with status report and update the inline data book or DDP status file. These steps repeat again at different stage of project as more firm design/ certified dimensional data is available.

Updating of the DDP status file is an important task after availability of the each level of dimensional data that needs to be taken into consideration by the originator. DDP Status file is used to track and identify date of last update, DDP dimensional data published in 3D model or not, symbols check in test model and errors if any.

At different phases of a project, control systems designer/ engineer can assess the existing avail dimensional data and provide to piping for modeling to avoid delay. The quality of data is categorized as follow:

S.No	Tag_Number	Status	P&ID	Instrument_Type_Desc	Quality of data available	DDP Released to 3D Coordinator	Latest Release Date	No. of times tag release	Symbol Checking	Release to Piping	Remarks
1	67-FE -0175I	7001	67-30-PE-50-0001-001	FLOW ELEMENT DP	PRELIM	No	12-Apr-12	5	No	No	
2	68-FE -0325I	7001	68-30-PE-50-0003-011	FLOW ELEMENT WEDGE	PRELIM	No	12-Apr-12	5	No	No	
3	81-FE -0141I	7001	81-30-PE-50-0203-013	FLOW ELMENT CORIOLIS	PRELIM	No	12-Apr-12	5	Yes	No	
4	67-XV -0156I	7002	67-30-PE-50-0001-001	ON OFF VALVE	DESGN	Yes	2-Jun-12	4	No	Yes	
5	79-PSV -04002	7002	79-30-PE-50-0004-021	PRESSURE SAFETY VALVE	DESGN	No	12-Apr-12	4	No	No	
6	79-FE -0400I	7003	79-30-PE-50-0004-021	FLOE ELEMENT VENTURI TUBE	CERT	Yes	2-Jun-12	6	Yes	Yes	Incorrect Orientation
7	81-FV -0150B	7003	81-30-PE-50-0207-007	FLOW VALVE	CERT	Yes	2-Jun-12	6	Yes	Yes	
8	81-EIV -0146I	7003	81-30-PE-50-0216-011	EMERGENCY ISOLATION VALVE	CERT	Yes	2-Jun-12	6	Yes	Yes	

Table.1: Shows the example of DDP Status file.

S.No	Codes	Quality of Data	Description
1	7001	Preliminary	Based on Library Data/ Reference from other project
2	7002	Design	Based on approved Vendor Catalog data
3	7003	Certified	Based on Certified Vendor Drawing

Table.2: Shows codes used to categorize the quality of data available.

CHECKING DDP IN 3D TEST MODEL

A. The following points needs to be checked in 3D Test Model for any randomly chosen in-line/ on-line instruments are:

1. Status of Instruments.
2. Weight of Instruments.
3. Accessibility for maintenance.
4. Pipe center to the top actuator.
5. Inlet/ outlet Size.
6. Inlet/ Outlet rating.
7. Face to Face dimension.
8. Actuator Height.
9. Actuator orientation.
10. Handwheel dimension.
11. Positioner/ Handwheel orientation.

B. The following points need to be considered for ensuring the quality of piping isometric drawing for instrumentation Item are:

1. The piping discipline place our instruments based from SPI DDP and SP3D instrument stock list report.
2. Instrument Tag should not be rename and/ or duplicate to use in another pipeline.
3. If any instrument tag is missing in SPI DDP list, then 1st inform to concern instrument delegate for further action.
4. The piping discipline must clear out the SP3D Diagnostic To Do List, Clash Report and Audit Report.
5. The instrument description for bill of material (BOM) should be come from SPI DDP module.

IV. MERITS OF USING NON-INTEGRATED METHOD

1. Low cost, due to bypassing the use of SPF database which is more costly.
2. Accurately data fetching.
3. Tracking of instruments becomes easier due to dimensional status code.
4. Reducing man hours- inputting dimensional data.
5. Reduction of checking time and maintaining documents.
6. Better revision management of dimensional data between piping and instrumentation.
7. Reduces dimensional data errors.

8. Design data matching with delivered instruments, thereby reduces construction costs.
9. Avoid the risk of installation space clashes and increase the accessibility for maintenance.
10. Avoid costly rework on-site by ensuring correct fit of components and verified by piping 3D Model clashes checking.
11. Minimize the risk of unsuitable instrument shipped.
12. Improve the quality of delivered data.
13. Speeding up order processing.

V. CONCLUSION

The expanding demand of highly schedule driven modular, skid-mounted, Offshore and nuclear projects requires consistent detailed inline/ online instrumentation dimensional data at different stage of the projects to avoid costly rework on-site by ensuring correct fit of components and verified by piping 3D model clashes checking. The proposed Non-Integrated Method finds most useful and effective way of providing in-line/ on-line instrument dimensional data to piping in the very initial phase of the project, thereby improving efficiency of designing instrumentation in 3D piping modeling with accurate vendor data to eliminate piping rework. Non-Integrated Method also helps to avoid quality issues on the isometrics, eliminating interface mismatches and improves ambiguity. This methods provides consistent dimensional data which eliminates piping rework, maintain better revision management of inline/ online data between piping and instrumentation. This results in reduction of checking time, maintaining documents and reduces dimensional data errors.

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Control & Protection – Conventional to Numerical Growth

Subhash Thakur (AGM, NTPC) *Arun Kr Sharma (Sr. Mgr. NTPC)*

Use of Electromechanical Relays in Electrical Switchyard and Control of Switchyards through conventional panels has become largely obsolete. Conventional Control and protection panels were all hardwired panels with huge amount of cables spreading across the control room. These conventional controls of electrical equipment were through control switches. These switches were placed on a mimic display of electrical system on the panel facia. This amounted to huge amount of cabling as well as complexity, both within and to/from panel interfaces for logic implantation and command execution. Use of Intelligent Electronic Devices (IED) has changed how Control & Protection of electrical breakers used to be in past. There have been continuous enhancements in capabilities of these IEDs. International standard & publications has changed the era of electrical protection.

Today World is talking about Internet of Things (IOT), the term has changed the way we all look at physical electronics around us. Similar development happened few years back when IEC 61850 was introduced as a de-facto communication protocol for Switchyard Automations. Today is the era where IEC61850 based substation automation system has overcome all initial roadblocks and allowed Interoperability, Centralized Control, optimal investment yielding better availability, reliability, maintenance and expandability. This paper presents Author's experience of conceptualization, design and implementation of IEC 61850 based Substation and advantages over other automation systems based on legacy protocols/ with hardwired C&R panels. View of as implemented networking architecture in Switchyard has also been presented. Other modes of networking and realization can be made however; these mostly depend on Technical Specification specified for SAS.

Electrical Control & Protection Systems have developed from Conventional Electromechanical relays to Digital Relays to Numerical Relays. Present system includes IEC 61850 compliant IEDs. We intend to see these from the point of view of EHV electrical system's availability, criticality, economics and extent of modernization planned. Impact of IEC 61850 compliant Numerical Relays vis-a-vis non-availability of spares & support for old electromechanical relays.

Keywords: IED, Numerical Relay, Conventional, Protection, Switchyard, IEC 61850, Engineering LAN, Network.

Notes

Notes

Notes

Notes

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- ☐ Engineering Services (8710)
- ☐ Government (9100)
- ☐ Instrument & Control Apparatus Sales & Service (5000)
- ☐ Management Consulting (8740)
- ☐ Research, Development & Testing (8730)

SIGNATURE : This application cannot be processed without your signature

Signature Date :

IndianOil

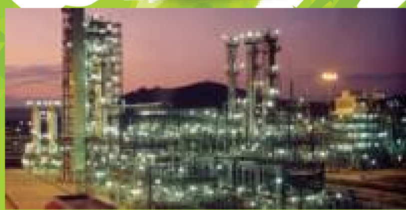
India's No. 1 Refiner

Gujarat Refinery 13.70 MMTPA

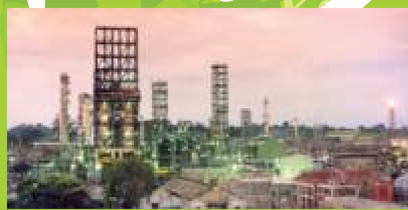
Haldia Refinery 7.5 MMTPA

Mathura Refinery 8.0 MMTPA

Panipat Refinery 15.0 MMTPA



Guwahati Refinery 1.0 MMTPA



Digboi Refinery 0.65 MMTPA

Barauni Refinery 6.0 MMTPA

Bongaigaon Refinery 2.35 MMTPA

Subsidiaries

CPCL-Chennai	10.50 MMTPA
Narimanam	1.0 MMTPA

(MMTPA-Million Metric Tonnes Per Annum, equal to 20,000 barrels per day)

Paradip Refinery 15 MMTPA

With the group refining capacity of 80.7 MMT per year, IndianOil is the largest oil refining company of the country.

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