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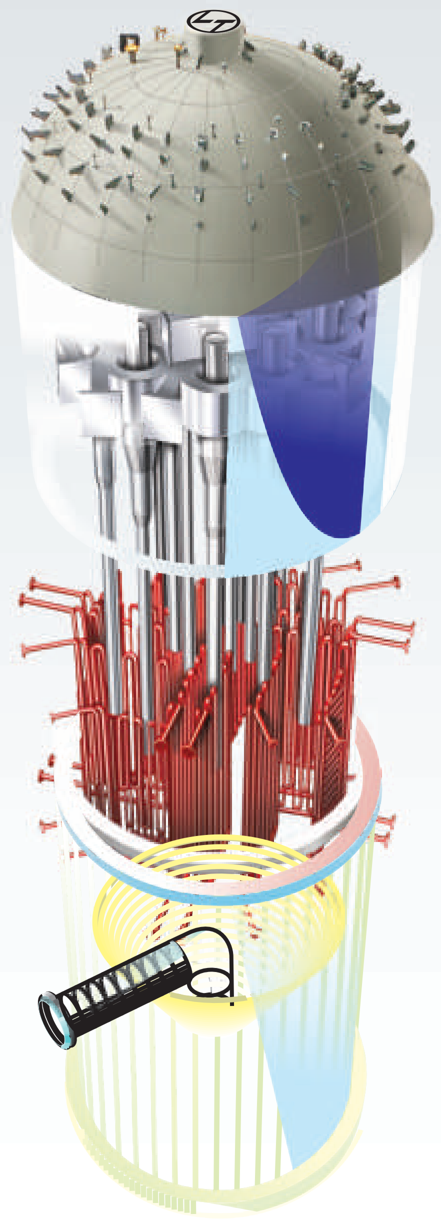

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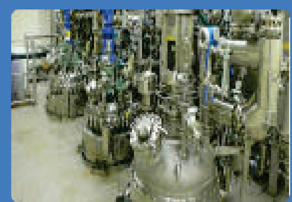

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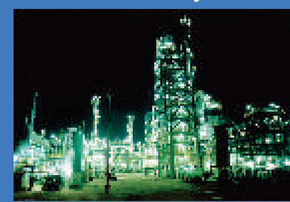

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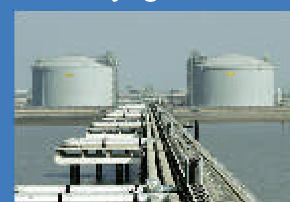

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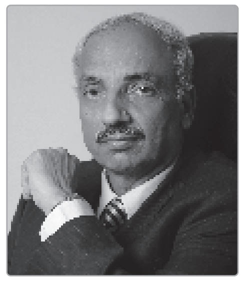

Dear Friends,

India is expected to achieve the projected growth rate of 7.4% in 2017 and further grow at 7.6 % in the next fiscal year based on strong consumption demand.

India's performing sectors include automobile, auto parts, engineering goods, petroleum refinery, pharmaceuticals and IT enabled services.

Similarly, India will reclaim its position as the fastest growing major global economy this year, partly propelled by benefits from a new tax system.

With the implementation of GST, manufacturing sector seems to revive as a result of reduced cost of production and restructuring of supply chain, propelled by the new tax regime.

The Indian manufacturing PMI in June 2017 declined to 50.9 in June from 51.6 in May 2017. The manufacturing sector saw weaker growth in June, due to softer expansion in new order work.

Nevertheless, manufacturers in India have an optimistic outlook towards the output growth in the next 12 months. New product developments and expectations of higher demand due to lower tax rates are expected to improve the manufacturing sector's activity in 2017, as per reports.

The effectiveness of GST will also activate an unmatched extension of services, capacity and new product lines, leading to an increase in manpower requirement.

This would spur an additional need to build training capacities considering jobs in labour intensive sectors demanding skilled and semi-skilled competencies in particular and capital intensive in general.

With the recovering global economy, strengthening multi-lateral co-operations, improvement in domestic demand and pick-up in global trade, there is opportunities galore to contribute to the economic growth.

Let us identify drivers for our industry, revisit strategies and focus areas which will help the industry in augmenting enterprise productiveness in every aspect.

Anil Rairikar

Chairman

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V.P. Ramachandran, Secretary General

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Economics of Nuclear Power Plants

George W. Bush signing the Energy Policy Act of 2005, which was designed to promote US nuclear reactor construction, through incentives and subsidies, including cost-overrun support up to a total of $2 billion for six new nuclear plants.

EDF has said its third-generation EPR Flamanville 3 project (seen here in 2010) will be delayed until 2018, due to "both structural and economic reasons," and the project's total cost has climbed to EUR 11 billion in 2012. Similarly, the cost of the EPR being built at Olkiluoto, Finland, has escalated dramatically, and the project is well behind schedule. The initial low cost forecasts for these megaprojects exhibited "optimism bias".

The economics of new nuclear power plants is a controversial subject, since there are diverging views on this topic (particularly around risk externalities involving disaster, cleanup, proliferation, disposal and resource conflict), and multibillion-dollar investments ride on the choice of an energy source.

New nuclear power plants typically have high capital costs for building the first several plants, after which costs tend to fall for each additional plant built as the supply chains develop and the regulatory processes settle down. Fuel, operational, and maintenance costs are relatively small components of the total cost. The long service life and high productivity of nuclear power plants allow sufficient funds for ultimate plant decommissioning and waste storage and management to be accumulated, with little impact on the price per unit of electricity generated. Additionally, measures to mitigate climate change such as a carbon tax or carbon emissions trading, would favor the economics of nuclear power over fossil fuel power.

Nuclear power construction costs have varied significantly across the world and in time. Massive and rapid increases in cost occurred in the 1970s, especially in the US, but these trends were much milder in other countries. There were no construction starts of nuclear power reactors between 1979 and 2012 in the US, and recent cost trends in countries such as Japan and Korea have been very different, including periods of stability and decline in cost.

In more economically developed countries, a slowdown in electricity demand growth in recent years has made large-scale power infrastructure investments difficult. Very large upfront costs and long project cycles carry large risks, including political decision making and intervention such as regulatory ratcheting. In Eastern Europe, a number of long-established projects are struggling to find finance, notably Belene in Bulgaria and the additional reactors at Cernavoda in Romania, and some potential backers have pulled out. Where cheap gas is available and its future supply relatively secure, this also poses a major problem for clean energy projects. Former Exelon CEO John Rowe said in 2012 that new nuclear plants in the US "don't make any sense right now" and won't be economic as long as gas prices remain low.

Current bids for new NPP's in China have fallen below $2000/kW in 2016, as China continues its accelerating new build program after the pause following the Fukushima meltdowns. Therefore, comparison with other power generation methods is strongly dependent on assumptions about construction timescales and capital financing for nuclear plants.

Analysis of the economics of nuclear power must take into account who bears the risks of future uncertainties. To date all operating nuclear power plants were developed by state-owned or regulated utility monopolies where many of the risks associated with political change and regulatory ratcheting were borne by consumers rather than suppliers. Many countries have now liberalized the electricity market where these risks, and the risk of cheap competition from subsidised energy sources emerging before capital costs are recovered, are borne by plant suppliers and operators rather than consumers, which leads to a significantly different evaluation of the risk of investing in new nuclear power plants.

Two of the four EPRs under construction (the Olkiluoto Nuclear Power Plant in Finland and Flamanville in France), which are the latest new builds in Europe, are significantly behind schedule and substantially over cost. Following the 2011 Fukushima Daiichi nuclear disaster, costs are likely to go up for some types of currently operating and new nuclear power plants, due to new requirements for on-site spent fuel management and elevated design basis threats.

Overview

Olkiluoto 3 under construction in 2009. It is the first EPR design, but problems with workmanship and supervision have created costly delays which led to an inquiry by the Finnish nuclear regulator STUK. In December 2012, Areva estimated that the full cost of building the reactor will be about 8.5 billion, or almost three times the original delivery price of 3 billion.

A 2016 review article in *Nature* (by Robert C. Armstrong, Catherine Wolfram, Robert Gross, Nathan S. Lewis, and M.V. Ramana et al.) says:

"The overwhelming factor shaping the future of nuclear power is its lack of economic competitiveness. Nuclear plants cost a lot to build and operate. This limits the rate of new reactor construction and causes utility companies to shut down reactors.

Although the price of new plants in China is falling rapidly, approaching $1500/kW or about a fifth of the cost of some plants currently being built in Europe, John Quiggin, an economics professor, maintains that the main problem with the nuclear option is that it is not economically viable. Professor of science and technology Ian Lowe has also challenged the economics of nuclear power. However, nuclear supporters continue to point to the historical success of nuclear power across the world, and they call for new reactors in their own countries, including proposed new but largely uncommercialised designs, as a source of new power. Nuclear supporters point out that the IPCC climate panel endorses nuclear technology as a low carbon, mature energy source which should be nearly quadrupled to help address soaring greenhouse gas emissions.

Some independent reviews keep repeating that nuclear power plants are necessarily very expensive, and anti-nuclear groups frequently produce reports that say the costs of nuclear energy are prohibitively high. This is despite the fact that in 2015 the cost of electricity in nuclear France is approximately the same as in Denmark and two-thirds of that in Germany.

In 2012 in Ontario, Canada, costs for nuclear generation stood at 5.9¢/kWh while hydroelectricity, at 4.3¢/kWh, cost 1.6¢ less than nuclear. By September 2015, the cost of solar in the US dropped below nuclear generation costs, averaging 5¢/kWh. Solar costs continued to fall, and by February 2016, the City of Palo Alto, California, approved a power-purchase agreement (PPA) to purchase solar electricity for under 3.68¢/kWh, lower than even hydroelectricity. Utility-scale solar electricity generation newly contracted by Palo Alto in 2016 costs 2.22¢/kWh less than electricity from the already-completed Canadian nuclear plants, and the costs of solar energy generation continue to drop.

Many countries, including Russia, South Korea, India, and China, have continued to pursue new builds. Globally, 71 nuclear power plants were under construction in 15 countries as of January 2015, according to the IAEA. China has 25 reactors under construction but, according to a government research unit, China must not build "too many nuclear power reactors too quickly", in order to avoid a shortfall of fuel, equipment and qualified plant workers. According to the World Nuclear Association, the global trend is for new nuclear power stations coming online to be balanced by the number of old plants being retired. But this worrying lack of development is limited to certain regions and may change once societies consider the importance of ample low cost and clean energy for their economies and quality of life.

In the United States, nuclear power faces competition from the low natural gas prices in North America. Former Exelon CEO John Rowe said in 2012 that new nuclear plants in the US "don't make any sense right now" and won't be economic as long as the natural gas glut persists. In 2016, Governor of New York Andrew Cuomo directed the New York Public Service Commission to consider ratepayer-financed subsidies similar to those for renewable sources to keep nuclear power stations profitable in the competition against natural gas.

Capital costs

"The usual rule of thumb for nuclear power is that about two thirds of the generation cost is accounted for by fixed costs, the main ones being the cost of paying interest on the loans and repaying the capital..."

Capital cost, the building and financing of nuclear power plants, represents a large percentage of the cost of nuclear electricity. In 2014, the US Energy Information Administration estimated that for new nuclear plants going online in 2019, capital costs will make up 74% of the levelized cost of electricity; higher than the capital percentages for fossil-fuel power plants (63% for coal, 22% for natural gas), and lower than the capital percentages for some other nonfossil-fuel sources (80% for wind, 88% for solar PV).

Areva, the French nuclear plant operator, offers that 70% of the cost of a kWh of nuclear electricity is accounted for by the fixed

costs from the construction process. Some analysts argue (for example Steve Thomas, Professor of Energy Studies at the University of Greenwich in the UK, quoted in the book The Doomsday Machine by Martin Cohen and Andrew McKillop) that what is often not appreciated in debates about the economics of nuclear power is that the cost of equity, that is companies using their own money to pay for new plants, is generally higher than the cost of debt. Another advantage of borrowing may be that "once large loans have been arranged at low interest rates - perhaps with government support - the money can then be lent out at higher rates of return".

"One of the big problems with nuclear power is the enormous upfront cost. These reactors are extremely expensive to build. While the returns may be very great, they're also very slow. It can sometimes take decades to recoup initial costs. Since many investors have a short attention span, they don't like to wait that long for their investment to pay off.

Because of the large capital costs for the initial nuclear power plants built as part of a sustained build program, and the relatively long construction period before revenue is returned, servicing the capital costs of first few nuclear power plants can be the most important factor determining the economic competitiveness of nuclear energy. The investment can contribute about 70% to 80% of the costs of electricity. The discount rate chosen to cost a nuclear power plant's capital over its lifetime is arguably the most sensitive parameter to overall costs. Because of the long life of new nuclear power plants, most of the value of a new nuclear power plant is created for the benefit of future generations.

The recent liberalization of the electricity market in many countries has made the economics of nuclear power generation less attractive, and no new nuclear power plants have been built in a liberalized electricity market. Previously a monopolistic provider could guarantee output requirements decades into the future. Private generating companies now have to accept shorter output contracts and the risks of future lower-cost competition from subsidised energy sources, so they desire a shorter return on investment period. This favours generation plant types with lower capital costs or high subsidies, even if associated fuel costs are higher. A further difficulty is that due to the large sunk costs but unpredictable future income from the liberalized electricity market, private capital is unlikely to be available on favourable terms, which is particularly significant for nuclear as it is capital-intensive. Industry consensus is that a 5% discount rate is appropriate for plants operating in a regulated utility environment where revenues are guaranteed by captive markets, and 10% discount rate is appropriate for a competitive deregulated or merchant plant environment; however the independent MIT study (2003) which used a more sophisticated finance model distinguishing equity and debt capital had a higher 11.5% average discount rate.

As states are declining to finance nuclear power plants, the sector is now much more reliant on the commercial banking sector. According to research done by Dutch banking research group Profundo, commissioned by Bank Track, in 2008 private banks invested almost 176 billion in the nuclear sector. Champions were BNP Paribas, with more than 13,5 billion in nuclear investments and Citigroup and Barclays on par with both over 11,4 billion in investments. Profundo added up investments in eighty companies in over 800 financial relationships with 124 banks in the following sectors: construction, electricity, mining, the nuclear fuel cycle and "other".

Cost overruns

Construction delays can add significantly to the cost of a plant. Because a power plant does not earn income and currencies can inflate during construction, longer construction times translate directly into higher finance charges. Modern nuclear power plants are planned for construction in five years or less (42 months for CANDU ACR-1000, 60 months from order to operation for an AP1000, 48 months from first concrete to operation for an EPR and 45 months for an ESBWR) as opposed to over a decade for some previous plants. However, despite Japanese success with ABWRs, two of the four EPRs under construction (in Finland and France) are significantly behind schedule.

In the U.S. many new regulations were put in place in the years before and again immediately after the Three Mile Island accident's partial meltdown, resulting in plant startup delays of many years. The NRC has new regulations in place now (see Combined Construction and Operating License), and the next plants will have NRC Final Design Approval before the customer buys them, and a Combined Construction and Operating License will be issued before construction starts, guaranteeing that if the plant is built as designed then it will be allowed to operate—thus avoiding lengthy hearings after completion.

In Japan and France, construction costs and delays are significantly diminished because of streamlined government licensing and certification procedures. In France, one model of reactor was type-certified, using a safety engineering process similar to the process used to certify aircraft models for safety. That is, rather than licensing individual reactors, the regulatory agency certified a particular design and its construction process to produce safe reactors. U.S. law permits type-licensing of reactors, a process which is being used on the AP1000 and the ESBWR.

In Canada, cost overruns for the Darlington Nuclear Generating Station, largely due to delays and policy changes, are often cited by opponents of new reactors. Construction started in 1981 at an estimated cost of $7.4 Billion 1993-adjusted CAD, and finished in 1993 at a cost of $14.5 billion. 70% of the price increase was due to interest charges incurred due to delays imposed to postpone units 3 and 4, 46% inflation over a 4-year period and other changes in financial policy. No new nuclear reactor has since been built in Canada, although a few have been and are undergoing refurbishment and environment assessment is complete for 4 new generation stations at Darlington with the Ontario government committed in keeping a nuclear base load of 50% or around 10GW.

In the UK and the US cost overruns on nuclear plants contributed to the bankruptcies of several utility companies. In the US these losses helped usher in energy deregulation in the mid-1990s that saw rising electricity rates and power blackouts in California. When the UK began privatizing utilities, its nuclear reactors "were so unprofitable they could not be sold." Eventually in 1996, the government gave them away. But the company that took them over, British Energy, had to be bailed out in 2004 to the extent of 3.4 billion pounds.

Operating costs

In general, coal and nuclear plants have the same types of operating costs (operations and maintenance plus fuel costs). However, nuclear has lower fuel costs but higher operating and maintenance costs.

Fuel costs

Nuclear plants require fissile fuel. Generally, the fuel used is uranium, although other materials may be used (See MOX fuel or Thorium). In 2005, prices on the world market for uranium averaged US$20/lb (US$44.09/kg). On 2007-04-19, prices reached US$113/lb (US$249.12/kg). On 2008-07-02, the price had dropped to $59/lb.

Fuel costs account for about 28% of a nuclear plant's operating expenses. As of 2013, half the cost of reactor fuel was taken up by enrichment and fabrication, so that the cost of the uranium concentrate raw material was 14 percent of operating costs. Doubling the price of uranium would add about 10% to the cost of electricity produced in existing nuclear plants, and about half that much to the cost of electricity in future power plants. The cost of raw uranium contributes about $0.0015/kWh to the cost of nuclear electricity, while in breeder reactors the uranium cost falls to $0.000015/kWh.

As of 2008, mining activity was growing rapidly, especially from smaller companies, but putting a uranium deposit into production takes 10 years or more. The world's present measured resources of uranium, economically recoverable at a price of 130 USD/kg according to the industry groups Organisation for Economic Co-operation and Development (OECD), Nuclear Energy Agency (NEA) and International Atomic Energy Agency (IAEA), are enough to last for "at least a century" at current consumption rates.

According to the World Nuclear Association, "the world's present measured resources of uranium (5.7 Mt) in the cost category less than three times present spot prices and used only in conventional reactors, are enough to last for about 90 years. This represents a higher level of assured resources than is normal for most minerals. Further exploration and higher prices will certainly, on the basis of present geological knowledge, yield further resources as present ones are used up." The amount of uranium present in all currently known conventional reserves alone (excluding the huge quantities of currently-uneconomical uranium present in "unconventional" reserves such as phosphate/phosphorite deposits, seawater, and other sources) is enough to last over 200 years at current consumption rates. Fuel efficiency in conventional reactors has increased over time. Additionally, since 2000, 12-15% of world uranium requirements have been met by the dilution of highly-enriched weapons-grade uranium from the decommissioning of nuclear weapons and related military stockpiles with depleted uranium, natural uranium, or partially-enriched uranium sources to produce low-enriched uranium for use in commercial power reactors. Similar efforts have been utilizing weapons-grade plutonium to produce mixed oxide (MOX) fuel, which is also produced from reprocessing used fuel. Other components of used fuel are currently less commonly utilized, but have a substantial capacity for reuse, especially so in next-generation fast neutron reactors. Over 35 European reactors are licensed to use MOX fuel, as well as Russian and American nuclear plants. Reprocessing of used fuel increases utilization by approximately 30%, while the widespread use of fast breeder reactors would allow for an increase of "50-fold or more" in utilization.

Waste disposal costs

All nuclear plants produce radioactive waste. To pay for the cost of storing, transporting and disposing these wastes in a permanent location, in the United States a surcharge of a tenth of a cent per kilowatt-hour is added to electricity bills. Roughly one percent of electrical utility bills in provinces using nuclear power are diverted to fund nuclear waste disposal in Canada.

In 2009, the Obama administration announced that the Yucca Mountain nuclear waste repository would no longer be considered the answer for U.S. civilian nuclear waste. Currently, there is no plan for disposing of the waste and plants will be required to keep the waste on the plant premises indefinitely.

The disposal of low level waste reportedly costs around £2,000/m^3 in the UK. High level waste costs somewhere between £67,000/m^3 and £201,000/m^3. General division is 80%/20% of low level/high level waste, and one reactor produces roughly 12 m^3 of high level waste annually.

In Canada, the NWMO was created in 2002 to oversee long term disposal of nuclear waste, and in 2007 adopted the Adapted Phased Management procedure. Long term management is subject to change based on technology and public opinion, but currently largely follows the recommendations for a centralized repository as first extensively outlined in by AECL in 1988. It was determined after extensive review that following these recommendations would safely isolate the waste from the biosphere. The location has not yet been determined, and the project is expected to cost between $9 and $13 billion CAD for construction and operation for 60–90 years, employing roughly a thousand people for the duration. Funding is available and has been collected since 1978 under the Canadian Nuclear Fuel Waste Management Program. Very long term monitoring requires less staff since high-level waste is less toxic than naturally occurring uranium ore deposits within a few centuries.

The primary argument for pursuing IFR-style technology today is that it provides the best solution to the existing nuclear waste problem because fast reactors can be fueled from the waste products of existing reactors as well as from the plutonium used in weapons, as is the case of the discontinued EBR-II in Arco, Idaho, and in the operating, as of 2014, BN-800 reactor. Depleted uranium (DU) waste can also be used as fuel in fast reactors. Waste produced by a fast-neutron reactor and a pyroelectric refiner would consist only of fission products, which are produced at a rate of about one tonne per GWe-year. This is 5% as much as present reactors produce, and needs special custody for only 300 years instead of 300,000. Only 9.2% of fission products (strontium and caesium) contribute 99% of radiotoxicity; at some additional cost, these could be separated, reducing the disposal problem by a further factor of ten.

Decommissioning

At the end of a nuclear plant's lifetime, the plant must be decommissioned. This entails either dismantling, safe storage or entombment. In the United States, the Nuclear Regulatory Commission (NRC) requires plants to finish the process within 60 years of closing. Since it may cost $500 million or more to shut down and decommission a plant, the NRC requires plant owners to set aside money when the plant is still operating to pay for the future shutdown costs.

Decommissioning a reactor that has undergone a meltdown is inevitably more difficult and expensive. Three Mile Island was decommissioned 14 years after its incident for $837 million. The cost of the Fukushima disaster cleanup is not yet known, but has been estimated to cost around $100 billion. Chernobyl is not yet decommissioned, different estimates put the end date between 2013 and 2020.

Proliferation and terrorism

A 2011 report for the Union of Concerned Scientists stated that "the costs of preventing nuclear proliferation and terrorism should be recognized as negative externalities of civilian nuclear power, thoroughly evaluated, and integrated into economic assessments—just as global warming emissions are increasingly identified as a cost in the economics of coal-fired electricity".

However the commercial exploitation of high grade uranium ore bodies, by the civil nuclear power sector, has reduced the uranium ore quality worldwide over time, and therefore this has increased the difficulty and effort that potential terrorists, or rogue states, must go through in order to sufficiently concentrate uranium from ore.

Proliferation risk is significant only in countries which are not signatories of non-proliferation treaties. The principle risk of proliferation concerns theft of, or illicit trade in nuclear materials used in industry and medicine. Ultimately, proliferation risk cannot be eliminated as long as nuclear power is used, because any country with sufficient funds could readily employ known legacy technologies to build a nuclear weapon from raw uranium ore. Civilian nuclear power plants in developed countries pose no credible proliferation risk.

Safety, security and accidents

2000 candles in memory of the Chernobyl disaster in 1986, at a commemoration 25 years after the nuclear accident, as well as for the Fukushima nuclear disaster of 2011.

Nuclear safety and security is a chief goal of the nuclear industry. Great care is taken so that accidents are avoided, and if unpreventable, have limited consequences. Accidents could stem from system failures related to faulty construction or pressure vessel embrittlement due to prolonged radiation exposure. As with any aging technology, risks of failure increase over time, and since many currently operating nuclear reactors were built in the mid-20th century, care must be taken to ensure proper operation. Many more recent reactor designs have been proposed, most of which include passive safety systems. These design considerations serve to significantly mitigate or totally prevent major accidents from occurring, even in the event of a system failure. Still, reactors must be designed, built, and operated properly to minimize accident risks. The Fukushima disaster represents one instance where these systems were not comprehensive enough, where the tsunami following the Thoku earthquake disabled the backup generators that were stabilizing the reactor. According to UBS AG, the Fukushima I nuclear accidents have cast doubt on whether even an advanced economy like Japan can master nuclear safety. Catastrophic scenarios involving terrorist attacks are also conceivable.

An interdisciplinary team from MIT estimated that given the expected growth of nuclear power from 2005 to 2055, at least four core damage incidents would be expected in that period (assuming only current designs were used - the number of incidents expected in that same time period with the use of advanced designs is only one). To date, there have been five core damage incidents in the world since 1970 (one at Three Mile Island in 1979; one at Chernobyl in 1986; and three at Fukushima-Daiichi in 2011), corresponding to the beginning of the operation of generation II reactors.

According to the Paul Scherrer Institute, the Chernobyl incident is the only incident ever to have caused any fatalities. The report that UNSCEAR presented to the UN General Assembly in 2011 states that 29 plant workers and emergency responders died from effects of radiation exposure, two died from causes related to the incident but unrelated to radiation, and one died from coronary thrombosis. It attributed fifteen cases of fatal thyroid cancer to the incident. It said there is no evidence the incident caused an ongoing increase in incidence of solid tumors or blood cancers in Eastern Europe. With 46 deaths in its entire six-decade worldwide history, nuclear power remains the safest-ever way to make electricity, by a very wide margin.

In terms of nuclear accidents, the Union of Concerned Scientists have claimed that "reactor owners ... have never been economically responsible for the full costs and risks of their operations. Instead, the public faces the prospect of severe losses in the event of any number of potential adverse scenarios, while private investors reap the rewards if nuclear plants are economically successful. For all practical purposes, nuclear power's economic gains are privatized, while its risks are socialized".

However, the problem of insurance costs for worst-case scenarios is not unique to nuclear power: hydroelectric power plants are similarly not fully insured against a catastrophic event such as the Banqiao Dam disaster, where 11 million people lost their homes and from 30,000 to 200,000 people died, or large dam failures in general. Private insurers base dam insurance premiums on worst-case scenarios, so insurance for major disasters in this sector is likewise provided by the state. In the US, insurance coverage for nuclear reactors is provided by the combination of operator-purchased private insurance and the primarily operator-funded Price Anderson Act.

Any effort to construct a new nuclear facility around the world, whether an existing design or an experimental future design, must deal with NIMBY or NIABY objections. Because of the high profiles of the Three Mile Island accident and Chernobyl disaster, relatively few municipalities welcome a new nuclear reactor, processing plant, transportation route, or deep geological repository within their borders, and some have issued local ordinances prohibiting the locating of such facilities there.

Nancy Folbre, an economics professor at the University of Massachusetts, has questioned the economic viability of nuclear power following the 2011 Japanese nuclear accidents:

The proven dangers of nuclear power amplify the economic risks of expanding reliance on it. Indeed, the stronger regulation and improved safety features for nuclear reactors called for in the wake of the Japanese disaster will almost certainly require costly provisions that may price it out of the market.

The cascade of problems at Fukushima, from one reactor to another, and from reactors to fuel storage pools, will affect the design, layout and ultimately the cost of future nuclear plants.

In 1986, Pete Planchon conducted a demonstration of the inherent safety of the Integral Fast Reactor. Safety interlocks were turned off. Coolant circulation was turned off. Core temperature rose from the usual 1000 degrees Fahrenheit to 1430 degrees within 20 seconds. The boiling temperature of the sodium coolant is 1621 degrees. Within seven minutes the reactor had shut itself down without action from the operators, without valves, pumps, computers, auxiliary power, or any moving parts. The temperature was below the operating temperature. The reactor was not damaged. The operators were not injured. There was no release of radioactive material. The reactor was restarted with coolant circulation but the steam generator disconnected. The same scenario recurred. Three weeks later, the operators at Chernobyl repeated the latter experiment, ironically in a rush to complete a safety test, using a very different reactor, with tragic consequences. Safety of the Integral Fast Reactor depends on the composition and geometry of the core, not efforts by operators or computer algorithms.

Insurance

Insurance available to the operators of nuclear power plants varies by nation. The worst case nuclear accident costs are so large that it would be difficult for the private insurance industry to carry the size of the risk, and the premium cost of full insurance would make nuclear energy uneconomic.

Nuclear power has largely worked under an insurance framework that limits or structures accident liabilities in accordance with the Paris convention on nuclear third-party liability, the Brussels supplementary convention, the Vienna convention on civil liability for nuclear damage, and in the US the Price-Anderson Act. It is often argued that this potential shortfall in liability represents an external cost not included in the cost of nuclear electricity.

However, the problem of insurance costs for worst-case scenarios is not unique to nuclear power: hydroelectric power plants are similarly not fully insured against a catastrophic event such as the Banqiao Dam disaster, where 11 million people lost their homes and from 30,000 to 200,000 people died, or large dam failures in general. Private insurers base dam insurance premiums on worst-case scenarios, so insurance for major disasters in this sector is likewise provided by the state.

In Canada, the Canadian Nuclear Liability Act requires nuclear power plant operators to obtain $650 million (CAD) of liability insurance coverage per installation (irregardless of the number of individual reactors present) starting in 2017 (up from the prior $75 million requirement established in 1976), increasing to $750 million in 2018, to $850 million in 2019, and finally to $1 billion in 2020. Claims beyond the insured amount would be assessed by a government appointed but independent tribunal, and paid by the federal government.

In the UK, the Nuclear Installations Act of 1965 governs liability for nuclear damage for which a UK nuclear licensee is responsible. The limit for the operator is £140 million.

In the United States, the Price-Anderson Act has governed the insurance of the nuclear power industry since 1957. Owners of nuclear power plants are required to pay a premium each year for the maximum obtainable amount of private insurance ($450 million) for each licensed reactor unit. This primary or "first tier" insurance is supplemented by a second tier. In the event a nuclear accident incurs damages in excess of $450 million, each licensee would be assessed a prorated share of the excess up to $121,255,000. With 104 reactors currently licensed to operate, this secondary tier of funds contains about $12.61 billion. This results in a maximum combined primary+secondary coverage amount of up to $13.06 billion for a hypothetical single-reactor incident. If 15 percent of these funds are expended, prioritization of the remaining amount would be left to a federal district court. If the second tier is depleted, Congress is committed to determine whether additional disaster relief is required. In July 2005, Congress extended the Price-Anderson Act to newer facilities.

The Vienna Convention on Civil Liability for Nuclear Damage and the Paris Convention on Third Party Liability in the Field of Nuclear Energy put in place two similar international frameworks for nuclear liability. The limits for the conventions vary. The Vienna convention was adapted in 2004 to increase the operator liability to 700 million per incident, but this modification is not yet ratified.

Cost per kWh

The cost per unit of electricity produced (kWh) will vary according to country, depending on costs in the area, the regulatory regime and consequent financial and other risks, and the availability and cost of finance. Costs will also depend on geographic factors such as availability of cooling water, earthquake likelihood, and availability of suitable power grid connections. So it is not possible to accurately estimate costs on a global basis.

Commodity prices rose in 2008, and so all types of plants became more expensive than previously calculated. In June 2008 Moody's estimated that the cost of installing new nuclear capacity in the U.S. might possibly exceed $7,000/KWe in final cost. In comparison, the reactor units already under construction in China have been reported with substantially lower costs due to significantly lower labour rates.

A 2008 study by former utility staff person Craig A. Severance based on historical outcomes in the U.S. said costs for nuclear power can be expected to run $0.25-0.30 per kWh.

A 2008 study concluded that if carbon capture and storage were required then nuclear power would be the cheapest source of electricity even at $4,038/kW in overnight capital cost.

In 2009, MIT updated its 2003 study, concluding that inflation and rising construction costs had increased the overnight cost of nuclear power plants to about $4,000/kWe, and thus increased the power cost to $0.084/kWh. The 2003 study had estimated the cost as $0.067/kWh.

According to Benjamin K. Sovacool, the marginal levelized cost for "a 1,000-MWe facility built in 2009 would be 41.2 to 80.3 cents/kWh, presuming one actually takes into account construction, operation and fuel, reprocessing, waste storage, and decommissioning".

A 2013 study indicates that the cost competitiveness of nuclear power is "questionable" and that public support will be required if new power stations are to be built within liberalized electricity markets.

In 2014, the US Energy Information Administration estimated the levelized cost of electricity from new nuclear power plants going online in 2019 to be $0.096/kWh before government subsidies, comparable to the cost of electricity from a new coal-fired power plant without carbon capture, but higher than the cost from natural gas-fired plants.

Comparisons with other power sources

Generally, a nuclear power plant is significantly more expensive to build than an equivalent coal-fueled or gas-fueled plant. If natural gas is plentiful and cheap operating costs of conventional power plants is less. Most forms of electricity generation produce some form of negative externality — costs imposed on third parties that are not directly paid by the producer — such as pollution which negatively affects the health of those near and downwind of the power plant, and generation costs often do not reflect these external costs.

A comparison of the "real" cost of various energy sources is complicated by several uncertainties:

- The cost of climate change through emissions of greenhouse gases is hard to estimate. Carbon taxes may be enacted, or carbon capture and storage may become mandatory.
- The cost of environmental damage caused by (fossil or renewable) energy sources, both through land use (whether for mining fuels or for power generation) and through air and water pollution and solid waste.
- The cost and political feasibility of disposal of the waste from reprocessed spent nuclear fuel is still not fully resolved. In the U.S., the ultimate disposal costs of spent nuclear fuel are assumed by the U.S. government after producers pay a fixed surcharge.
- Operating reserve requirements are different for different generation methods. When nuclear units shut down unexpectedly they tend to do so independently, so the "hot spinning reserve" must be at least the size of the largest unit (this partly makes nuclear power more suitable for large grids). On the other hand, many renewables are intermittent power sources and may shut down together if they depend on weather conditions, so the grid will require a combination of back-up generation capability, extensive transmission or large-scale storage if the portion of generation from these renewables is significant. (Some firm renewables such as hydroelectricity have a storage reservoir and can be used as reliable back-up power for other power sources.)
- Governmental instabilities in the next plant lifetime. New nuclear power plants are designed for a minimum of 60 years, and may be able to be refurbished. Likewise, the waste from reprocessed fuel remains dangerous for various periods depending on type, however reprocessing/reuse of spent nuclear fuel can add future value as well. A governmental change of opinion may impact the overall plant economy.
- Actual plant lifetime (to date, no plant has been shut down due to maximum licensed lifetime being reached, or been refurbished).
- Due to the dominant role of initial construction cost and the multi-year construction time and planned lifetime, the interest rate for the capital required is of particularly high importance for estimating the total cost.

A UK Royal Academy of Engineering report in 2004 looked at electricity generation costs from new plants in the UK. In particular it aimed to develop "a robust approach to compare directly the costs of intermittent generation with more dependable sources of generation". This meant adding the cost of standby capacity for wind, as well as carbon values up to £30 (45.44) per tonne CO_2 for coal and gas. Wind power was calculated to be more than twice as expensive as nuclear power. Without a carbon tax, the cost of production through coal, nuclear and gas ranged £0.022 – 0.026/kWh and coal gasification was £0.032/kWh. When carbon tax was added (up to £0.025) coal came close to onshore wind (including back-up power) at £0.054/kWh — offshore wind is £0.072/kWh — nuclear power remained at £0.023/kWh either way, as it produces negligible amounts of CO_2. (Nuclear figures included estimated decommissioning costs.)

A May 2008 study by the Congressional Budget Office concludes that a carbon tax of $45 per tonne of carbon dioxide would probably make nuclear power cost competitive against conventional fossil fuel for electricity generation.

Estimates of total lifetime energy returned on energy invested vary greatly depending on the study. An overview can be found here (Table 2):

The effect of subsidies is difficult to gauge, as some are indirect (such as research and development). A May 12, 2008 editorial in the Wall Street Journal stated, "For electricity generation, the EIA (Energy Information Administration, an office of the Department of Energy) concludes that solar energy is subsidized to the tune of $24.34 per megawatt hour, wind $23.37 and 'clean coal' $29.81. By contrast, normal coal receives 44 cents, natural gas a mere quarter, hydroelectric about 67 cents and nuclear power $1.59.

The Lazard financial analyse firm version 9 energy report estimate unsubsidized prices of $97-$136 nuclear, solar pv $50-$60 and wind at $32-$77.

However, the most important subsidies to the nuclear industry do not involve cash payments. Rather, they shift construction costs and operating risks from investors to taxpayers and ratepayers, burdening them with an array of risks including cost overruns, defaults to accidents, and nuclear waste management. This approach has remained remarkably consistent throughout the nuclear industry's history, and distorts market choices that would otherwise favor less risky energy investments.

In 2011, Benjamin K. Sovacool said that: "When the full nuclear fuel cycle is considered — not only reactors but also uranium mines and mills, enrichment facilities, spent fuel repositories, and decommissioning sites — nuclear power proves to be one of the costliest sources of energy".

In 2014, Brookings Institution published The Net Benefits of Low and No-Carbon Electricity Technologies which states, after performing an energy and emissions cost analysis, that "The net benefits of new nuclear, hydro, and natural gas combined cycle plants far outweigh the net benefits of new wind or solar plants", with the most cost effective low carbon power technology being determined to be nuclear power. Moreover, Paul Joskow of MIT has determined that the "Levelized cost of electricity" (LCOE) metric is a poor means of comparing electricity sources as it hides the extra costs, such as the need to frequently operate back up power stations, incurred due to the use of intermittent power sources such as wind energy, while the value of baseload power sources are underpresented.

An EU-funded research study known as ExternE, or Externalities of Energy, undertaken from 1995 to 2005, found that the cost of producing electricity from coal or oil would double, and the cost of electricity production from gas would increase by 30% if external costs such as damage to the environment and to human health, from the particulate matter, nitrogen oxides, chromium VI, river water alkalinity, mercury poisoning and arsenic emissions produced by these sources, were taken into account. It was estimated in the study that these external, downstream, fossil fuel costs amount up to 1-2% of the EU's Gross Domestic Product, and this was before the external cost of global warming from these sources was included. The study also found that the environmental and health costs of nuclear power, per unit of energy delivered, was lower than many renewable sources, including that caused by biomass and photovoltaic solar panels, but was higher than the external costs associated with wind power and alpine hydropower.

Other economic issues

Kristin Shrader-Frechette analysed 30 papers on the economics of nuclear power for possible conflicts of interest. She found of the 30, 18 had been funded either by the nuclear industry or pro-nuclear governments and were pro-nuclear, 11 were funded by universities or non-profit non-government organisations and were anti-nuclear, the remaining 1 had unknown sponsors and took the pro-nuclear stance. The pro-nuclear studies were accused of using cost-trimming methods such as ignoring government subsides and using industry projections above empirical evidence where ever possible. The situation was compared to medical research where 98% of industry sponsored studies return positive results.

Nuclear Power plants tend to be very competitive in areas where other fuel resources are not readily available — France, most notably, has almost no native supplies of fossil fuels. France's nuclear power experience has also been one of paradoxically increasing rather than decreasing costs over time.

Making a massive investment of capital in a project with long-term recovery might affect a company's credit rating.

A Council on Foreign Relations report on nuclear energy argues that a rapid expansion of nuclear power may create shortages in building materials such as reactor-quality concrete and steel, skilled workers and engineers, and safety controls by skilled inspectors. This would drive up current prices. It may be easier to rapidly expand, for example, the number of coal power plants, without this having a large effect on current prices.

Some existing LWR type plants have limited ability to significantly vary their output to match changing demand (called load-following). Other PWRs, as well as CANDU, BWR have load-following capability, which will allow them to fill more than baseline generation needs. Some newer reactors also offer some form of enhanced load-following capability. For example, the Areva EPR can slew its electrical output power between 990 and 1,650 MW at 82.5 MW per minute. The number of companies that manufacture certain parts for nuclear reactors is limited, particularly the large forgings used for reactor vessels and steam systems. Only four companies (Japan Steel Works, China First Heavy Industries, Russia's OMZ Izhora and Korea's Doosan Heavy Industries) currently manufacture pressure vessels for reactors of 1100 MGe or larger. Some have suggested that this poses a bottleneck that could hamper expansion of nuclear power internationally; however, some Western reactor designs require no steel pressure vessel such as CANDU derived reactors which rely on individual pressurized fuel channels. The large forgings for steam generators — although still very heavy — can be produced by a far larger number of suppliers.

Recent trends

Brunswick Nuclear Plant discharge canal

The Bruce Nuclear Generating Station, the largest nuclear power facility in the world

The nuclear power industry in Western nations has a history of construction delays, cost overruns, plant cancellations, and nuclear safety issues despite significant government subsidies and support. In December 2013, Forbes magazine reported that, in developed countries, "reactors are not a viable source of new power". Even in developed nations where they make economic sense, they are not feasible because nuclear's "enormous costs, political and popular opposition, and regulatory uncertainty". This view echoes the statement of former Exelon CEO John Rowe, who said in 2012 that new nuclear plants "don't make any sense right now" and won't be economically viable in the foreseeable future. John Quiggin, economics professor, also says the main problem with the nuclear option is that it is not economically-viable. Quiggin says that we need more efficient energy use and more renewable energy commercialization. Former NRC member Peter Bradford and Professor Ian Lowe have recently made similar statements. However, some "nuclear cheerleaders" and lobbyists in the West continue to champion reactors, often with proposed new but largely untested designs, as a source of new power.

Significant new build activity is occurring in developing countries like South Korea, India and China. China has 25 reactors under construction, However, according to a government research unit, China must not build "too many nuclear power reactors too quickly", in order to avoid a shortfall of fuel, equipment and qualified plant workers.

The 1.6 GWe EPR reactor is being built in Olkiluoto Nuclear Power Plant, Finland. A joint effort of French AREVA and German Siemens AG, it will be the largest pressurized water reactor (PWR) in the world. The Olkiluoto project has been claimed to have benefited from various forms of government support and subsidies, including liability limitations, preferential financing rates, and export credit agency subsidies, but the European Commission's investigation didn't find anything illegal in the proceedings. However, as of August 2009, the project is "more than three years behind schedule and at least 55% over budget, reaching a total cost estimate of 5 billion ($7 billion) or close to 3,100 ($4,400) per kilowatt". Finnish electricity consumers interest group ElFi OY evaluated in 2007 the effect of Olkiluoto-3 to be slightly over 6%, or 3/MWh, to the average market price of electricity within Nord Pool Spot. The delay is therefore costing the Nordic countries over 1.3 billion euros per year as the reactor would replace more expensive methods of production and lower the price of electricity.

Russia has begun building the world's first floating nuclear power plant. The £100 million vessel, the Akademik Lomonosov, is the first of seven plants (70 MWe per ship) that Moscow says will bring vital energy resources to remote Russian regions.

Following the Fukushima nuclear disaster in 2011, costs are likely to go up for currently operating and new nuclear power plants, due to increased requirements for on-site spent fuel management and elevated design basis threats. After Fukushima, the International Energy Agency halved its estimate of additional nuclear generating capacity built by 2035.

Many license applications filed with the U.S. Nuclear Regulatory Commission for proposed new reactors have been suspended or cancelled. As of October 2011, plans for about 30 new reactors in the United States have been reduced to 14. There are currently five new nuclear plants under construction in the United States (Watts Bar 2, Summer 2, Summer 3, Vogtle 3, Vogtle 4). Matthew Wald from the New York Times has reported that "the nuclear renaissance is looking small and slow".

In 2013, four aging, uncompetitive reactors were permanently closed in the US: San Onofre 2 and 3 in California, Crystal River 3 in Florida, and Kewaunee in Wisconsin. The state of Vermont is trying to close Vermont Yankee, in Vernon. New York State is seeking to close Indian Point Nuclear Power Plant, in Buchanan, 30 miles from New York City. The additional cancellation of five large reactor uprates (Prairie Island, 1 reactor, LaSalle, 2 reactors, and Limerick, 2 rectors), four by the largest nuclear company in the U.S., suggest that the nuclear industry faces "a broad range of operational and economic problems".

As of July 2013, economist Mark Cooper has identified some US nuclear power plants that face particularly significant challenges to their continued operation due to regulatory challenges by local politicians. These are Palisades, Fort Calhoun, Nine Mile Point, Fitzpatrick, Ginna, Oyster Creek, Vermont Yankee, Millstone, Clinton, Indian Point. Cooper said the lesson here for policy makers and economists is clear: "nuclear reactors are simply not competitive".

Safety Valve

An oxygen safety relief valve

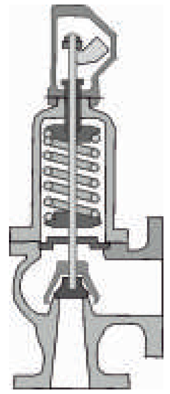
ND250-safety valves

A **safety valve** is a valve that acts as a fail-safe in a thermal-hydraulics plant. An example of safety valve is a pressure relief valve (PRV), which automatically releases a substance from a boiler, pressure vessel, or other system, when the pressure or temperature exceeds preset limits. Pilot-operated relief valves are a specialized type of pressure safety valve.

Safety valves were first developed for use on steam boilers during the Industrial Revolution. Early boilers operating without them were prone to explosion.

Vacuum safety valves (or combined pressure/vacuum safety valves) are used to prevent a tank from collapsing while it is being emptied, or when cold rinse water is used after hot CIP (clean-in-place) or SIP (sterilization-in-place) procedures. When sizing a vacuum safety valve, the calculation method is not defined in any norm, particularly in the hot CIP / cold water scenario, but some manufacturers have developed sizing simulations.

Function and design



A cross-section of a proportional-safety valve

The earliest and simplest safety valve was used on a 1679 steam digester and utilized a weight to retain the steam pressure (this design is still commonly used on pressure cookers); however, these were easily tampered with or accidentally released. On the Stockton and Darlington Railway, the safety valve tended to go off when the engine hit a bump in the track. A valve less sensitive to sudden accelerations used a spring to contain the steam pressure, but these (based on a Salter spring balance) could still be screwed down to increase the pressure beyond design limits. This dangerous practice was sometimes used to marginally increase the performance of a steam engine. In 1856, John Ramsbottom invented a tamper-proof spring safety valve that became universal on railways.

Safety valves also evolved to protect equipment such as pressure vessels (fired or not) and heat exchangers. The term **safety valve** should be limited to compressible fluid applications (gas, vapor, or steam).

The two general types of protection encountered in industry are thermal protection and flow protection.

For liquid-packed vessels, thermal relief valves are generally characterized by the relatively small size of the valve necessary to provide protection from excess pressure caused by thermal expansion. In this case a small valve is adequate because most liquids are nearly incompressible, and so a relatively small amount of fluid discharged through the relief valve will produce a substantial reduction in pressure.

Flow protection is characterized by safety valves that are considerably larger than those mounted for thermal protection. They are generally sized for use in situations where significant quantities of gas or high volumes of liquid must be quickly discharged in order to protect the integrity of the vessel or pipeline. This protection can alternatively be achieved by installing a high integrity pressure protection system (HIPPS).

Technical terms

In the petroleum refining, petrochemical, chemical manufacturing, natural gas processing, power generation, food, drinks, cosmetics and pharmaceuticals industries, the term safety valve is associated with the terms **pressure relief valve** (PRV), pressure **safety valve** (PSV) and relief valve. The generic term is **Pressure relief valve** (PRV) or **pressure safety valve** (PSV) It should be noted that PRVs and PSVs are not the same thing, despite what many people think; the difference is that PSVs have a manual lever to open the valve in case of emergency.

- Relief valve (RV): an automatic system that is actuated by the static pressure in a liquid-filled vessel. It specifically opens proportionally with increasing pressure
- Safety valve (SV): an automatic system that relieves the static pressure on a gas. It usually opens completely, accompanied by a popping sound
- **Safety relief valve** (SRV): an automatic system that relieves by static pressure on both gas and liquid.
- **Pilot-operated safety relief valve** (POSRV): an automatic system that relieves on remote command from a pilot, to which the static pressure (from equipment to protect) is connected
- **Low pressure safety valve** (LPSV): an automatic system that relieves static pressure on a gas. Used when the difference between the vessel pressure and the ambient atmospheric pressure is small.
- **Vacuum pressure safety valve** (VPSV): an automatic system that relieves static pressure on a gas. Used when the pressure difference between the vessel pressure and the ambient pressure is small, negative and near to atmospheric pressure.
- **Low and vacuum pressure safety valve** (LVPSV): an automatic system that relieves static pressure on a gas. The pressure is small, negative or positive, and near to atmospheric pressure.

RV, SV and SRV are spring-operated (even spring-loaded). LPSV and VPSV are spring-operated or weight-loaded.

Legal and code requirements in industry

In most countries, industries are legally required to protect pressure vessels and other equipment by using relief valves. Also, in most countries, equipment design codes such as those provided by the ASME, API and other organizations like ISO (ISO 4126) must be complied with. These codes include design standards for relief valves and schedules for periodic inspection and testing after valves have been removed by the company engineer or axelpetugrantist

Today, the food, drinks, cosmetics, pharmaceuticals and fine chemicals industries call for hygienic safety valves, fully drainable and Cleanable-In-Place. Most are made of stainless steel; the hygienic norms are mainly 3A in the USA and EHEDG in Europe.

Water heaters

Temperature and Pressure safety valve on a water heater.

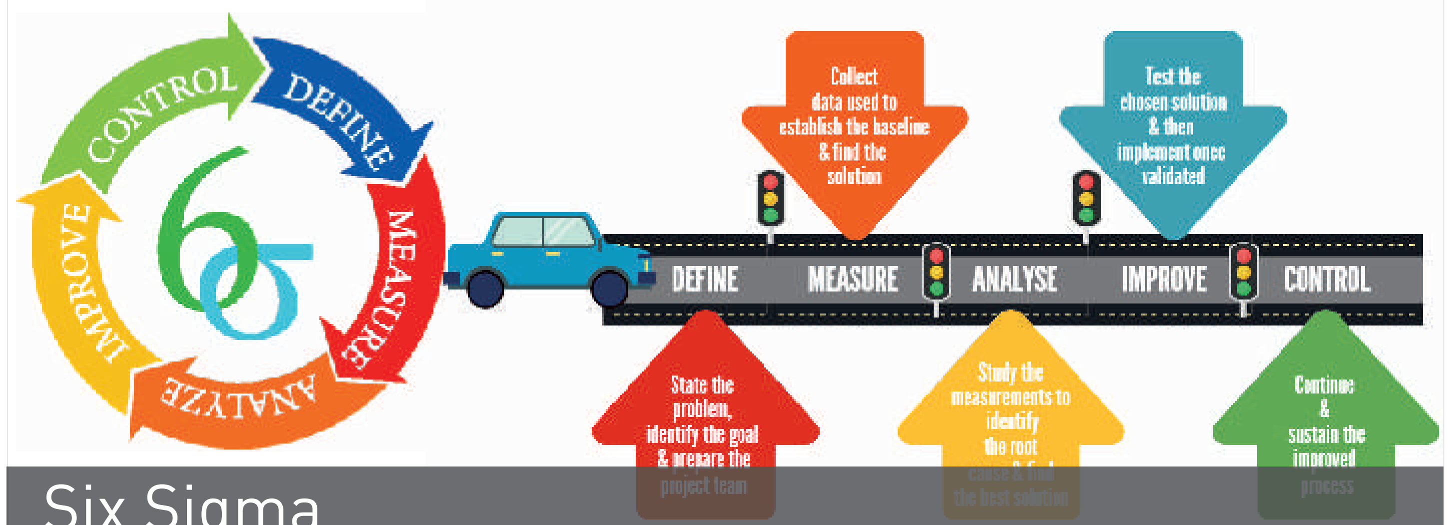
Safety valves are required on water heaters, where they prevent disaster in certain configurations in the event that a thermostat should fail. There are still occasional, spectacular failures of older water heaters that lack this equipment. Houses can be leveled by the force of the blast.

Pressure cookers

Pressure cookers are cooking pots with a pressure-proof lid. Cooking at pressure allows the temperature to rise above the normal boiling point of water (100 degrees Celsius at sea level), which speeds up the cooking and makes it more thorough.

Pressure cookers usually have two safety valves to prevent explosions. On older designs, one is a nozzle upon which a weight sits. The other is a sealed rubber grommet which is ejected in a controlled explosion if the first valve gets blocked. On newer generation pressure cookers, if the steam vent gets blocked, a safety spring will eject excess pressure and if that fails, the gasket will expand and release excess pressure downwards between the lid and the pan. Also, newer generation pressure cookers have a safety interlock which locks the lid when internal pressure exceeds atmospheric pressure, to prevent accidents from a sudden release of very hot steam, food and liquid, which would happen if the lid were to be removed when the pan is still slightly pressurised inside (however, the lid will be very hard or impossible to open when the pan is still pressurised).

The term *safety valve* is also used metaphorically.



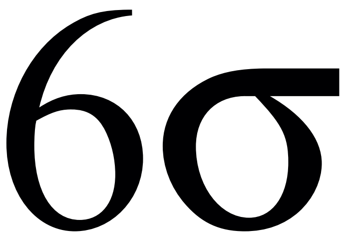
Six Sigma

Six Sigma (6σ) is a set of techniques and tools for process improvement. It was introduced by engineers Bill Smith & Mikel J Harry while working at Motorola in 1986. Jack Welch made it central to his business strategy at General Electric in 1995.

It seeks to improve the quality of the output of a process by identifying and removing the causes of defects and minimizing variability in manufacturing and business processes. It uses a set of quality management methods, mainly empirical, statistical methods, and creates a special infrastructure of people within the organization who are experts in these methods. Each Six Sigma project carried out within an organization follows a defined sequence of steps and has specific value targets, for example: reduce process cycle time, reduce pollution, reduce costs, increase customer satisfaction, and increase profits.

The term *Six Sigma* (capitalized because it was written that way when registered as a Motorola trademark on December 28, 1993) originated from terminology associated with statistical modeling of manufacturing processes. The maturity of a manufacturing process can be described by a *sigma* rating indicating its yield or the percentage of defect-free products it creates. A six sigma process is one in which 99.99966% of all opportunities to produce some feature of a part are statistically expected to be free of defects (3.4 defective features per million opportunities). Motorola set a goal of "six sigma" for all of its manufacturing operations, and this goal became a by-word for the management and engineering practices used to achieve it.

Doctrine


The common Six Sigma symbol

Six Sigma doctrine asserts:

- Continuous efforts to achieve stable and predictable process results (e.g. by reducing process variation) are of vital importance to business success.
- Manufacturing and business processes have characteristics that can be defined, measured, analyzed, improved, and controlled.
- Achieving sustained quality improvement requires commitment from the entire organization, particularly from top-level management.

Features that set Six Sigma apart from previous quality improvement initiatives include:

- A clear focus on achieving measurable and quantifiable financial returns from any Six Sigma project.
- An increased emphasis on strong and passionate management leadership and support.
- A clear commitment to making decisions on the basis of verifiable data and statistical methods, rather than assumptions and guesswork.

The term "six sigma" comes from statistics and is used in statistical quality control, which evaluates process capability. Originally, it referred to the ability of manufacturing processes to produce a very high proportion of output within specification. Processes that operate with "six sigma quality" over the short term are assumed to produce long-term defect levels below 3.4 defects per million opportunities (DPMO). Six Sigma's implicit goal is to improve all processes, but not to the 3.4 DPMO level necessarily. Organizations need to determine an appropriate sigma level for each of their most important processes and strive to achieve these. As a result of this goal, it is incumbent on management of the organization to prioritize areas of improvement.

"Six Sigma" was registered June 11, 1991 as U.S. Service Mark 1,647,704. In 2005 Motorola attributed over US$17 billion in savings to Six Sigma.

WORKSHOP ON GOODS AND SERVICE TAX (GST)


General secretary welcoming
The delegates and introducing the faculty


Mr. Tushar Pathak,
Chief Guest addressing the audience.


Mr. Aniket Kulkarni,
Faculty giving presentation on GST.


Section of audience


Mr. Aniket Kulkarni, faculty giving certificate of
Attendance to the delegates on behalf of PPMAI

PPMAI has conducted a quality program on GOODS AND SERVICE TAX (GST) on 21st July 2017 at Hotel Rang Sharda, Bandra Reclamation, Bandra West, Mumbai. The programme was went off very well. 24 delegates from the following companies were participated in the programme.

- **Aarvi Encon Pvt. Ltd.**
- **Aero Engineers**
- **Chemical Process Piping Pvt. Ltd.**
- **Chemtrols Industries Pvt. Ltd.**
- **G. R. Engineering Pvt. Ltd.**
- **Toyo Engineering India Pvt. Ltd.**

Mr. Aniket Kulkarni, Tax Consultant from Aniket Kulkarni & Associates, Chartered Accountant was the Faculty for this event. Mr. Tushar Pathak, Head Finance & Accounts of Toyo Engineering India Pvt. Ltd., was the Chief Guest.

There was excellent interaction from the delegates, who have been able to clear all their doubts and carry home a good knowledge on implications and applicability of GST for their day to day activities.

Secretary General concluded the program with a Vote of Thanks. Mr. Aniket Kulkarni on behalf of PPMAI handed over the Certificate of Attendance to all the participants.

Other early adopters of Six Sigma include Honeywell and General Electric, where Jack Welch introduced the method. By the late 1990s, about two-thirds of the Fortune 500 organizations had begun Six Sigma initiatives with the aim of reducing costs and improving quality.

In recent years, some practitioners have combined Six Sigma ideas with lean manufacturing to create a methodology named Lean Six Sigma. The Lean Six Sigma methodology views lean manufacturing, which addresses process flow and waste issues, and Six Sigma, with its focus on variation and design, as complementary disciplines aimed at promoting "business and operational excellence". Companies such as GE, Accenture, Verizon, GENPACT, and IBM use Lean Six Sigma to focus transformation efforts not just on efficiency but also on growth. It serves as a foundation for innovation throughout the organization, from manufacturing and software development to sales and service delivery functions.

The International Organization for Standardization (ISO) has published in 2011 the first standard "ISO 13053:2011" defining a Six Sigma process. Other "standards" are created mostly by universities or companies that have so-called first-party certification programs for Six Sigma.

Difference between related concepts

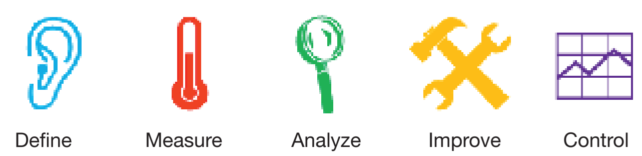
Lean management and Six Sigma are two concepts which share similar methodologies and tools. Both programs are Japanese influenced, but they are two different programs. Lean management is focused on eliminating waste and ensuring efficiency while Six Sigma's focus is on eliminating defects and reducing variability.

Methodologies

Six Sigma projects follow two project methodologies inspired by Deming's Plan-Do-Check-Act Cycle. These methodologies, composed of five phases each, bear the acronyms DMAIC and DMADV.

- DMAIC **("duh-may-ick", /d□.□me□.□k/)** is used for projects aimed at improving an existing business process.
- DMADV **("duh-mad-vee", /d□.□mæd.vi/)** is used for projects aimed at creating new product or process designs.

DMAIC



The DMAIC project methodology has five phases:

- *Define* the system, the voice of the customer and their requirements, and the project goals, specifically.
- *Measure* key aspects of the current process and collect relevant data; calculate the 'as-is' Process Capability.
- *Analyze* the data to investigate and verify cause-and-effect relationships. Determine what the relationships are, and attempt to ensure that all factors have been considered. Seek out root cause of the defect under investigation.
- *Improve* or optimize the current process based upon data analysis using techniques such as design of experiments, experiments, poka yoke or mistake proofing, and standard work to create a new, future state process. Set up pilot runs to establish process capability.
- *Control* the future state process to ensure that any deviations from the target are corrected before they result in defects. Implement control systems such as statistical process control, production boards, visual workplaces, and continuously monitor the process. This process is repeated until the desired quality level is obtained.

Some organizations add a ***R****ecognize* step at the beginning, which is to recognize the right problem to work on, thus yielding an RDMAIC methodology.

DMADV or DFSS

The five steps of DMADV

The DMADV project methodology, known as DFSS ("**D**esign **F**or **S**ix **S**igma"), features five phases:

- **D**efine design goals that are consistent with customer demands and the enterprise strategy.
- **M**easure and identify CTQs (characteristics that are **C**ritical **T**o **Q**uality), measure product capabilities, production process capability, and measure risks.
- **A**nalyze to develop and design alternatives
- **D**esign an improved alternative, best suited per analysis in the previous step
- **V**erify the design, set up pilot runs, implement the production process and hand it over to the process owner(s).

Quality management tools and methods

Within the individual phases of a DMAIC or DMADV project, Six Sigma utilizes many established quality-management tools that are also used outside Six Sigma. The following table shows an overview of the main methods used.

- 5 Whys
- Statistical and fitting tools
  - Analysis of variance
  - General linear model
  - ANOVA Gauge R&R
  - Regression analysis
  - Correlation
  - Scatter diagram
  - Chi-squared test
- Axiomatic design
- Business Process Mapping/Check sheet
- Cause & effects diagram (also known as fishbone or Ishikawa diagram)
- Control chart/Control plan (also known as a swimlane map)/Run charts
- Cost-benefit analysis
- CTQ tree
- Design of experiments/Stratification
- Histograms/Pareto analysis/Pareto chart
- Pick chart/Process capability/Rolled throughput yield
- Quality Function Deployment (QFD)
- Quantitative marketing research through use of Enterprise Feedback Management (EFM) systems
- Root cause analysis
- SIPOC analysis (**S**uppliers, **I**nputs, **P**rocess, **O**utputs, **C**ustomers)
- COPIS analysis (Customer centric version/perspective of SIPOC)
- Taguchi methods/Taguchi Loss Function
- Value stream mapping

Implementation roles

One key innovation of Six Sigma involves the absolute "professionalizing" of quality management functions. Prior to Six Sigma, quality management in practice was largely relegated to the production floor and to statisticians in a separate quality department. Formal Six Sigma programs adopt a kind of elite ranking terminology (similar to some martial arts systems, like judo) to define a hierarchy (and special career path) that includes all business functions and levels.

Six Sigma identifies several key roles for its successful implementation.

- *Executive Leadership* includes the CEO and other members of top management. They are responsible for setting up a vision for Six Sigma implementation. They also empower the other role holders with the freedom and resources to explore new ideas for breakthrough improvements by transcending departmental barriers and overcoming inherent resistance to change.
- *Champions* take responsibility for Six Sigma implementation across the organization in an integrated manner. The Executive Leadership draws them from upper management. Champions also act as mentors to Black Belts.
- *Master Black Belts*, identified by Champions, act as in-house coaches on Six Sigma. They devote 100% of their time to Six Sigma. They assist Champions and guide Black Belts and Green Belts. Apart from statistical tasks, they spend their time on ensuring consistent application of Six Sigma across various functions and departments.
- *Black Belts* operate under Master Black Belts to apply Six Sigma methodology to specific projects. They devote 100% of their valued time to Six Sigma. They primarily focus on Six Sigma project execution and special leadership with special tasks, whereas Champions and Master Black Belts focus on identifying projects/functions for Six Sigma.
- *Green Belts* are the employees who take up Six Sigma implementation along with their other job responsibilities, operating under the guidance of Black Belts.

According to proponents of the system, special training is needed for all of these practitioners to ensure that they follow the methodology and use the data-driven approach correctly.

Some organizations use additional belt colours, such as *Yellow Belts*, for employees that have basic training in Six Sigma tools and generally participate in projects and "White belts" for those locally trained in the concepts but do not participate in the project team. "Orange belts" are also mentioned to be used for special cases.

Certification

General Electric and Motorola developed certification programs as part of their Six Sigma implementation, verifying individuals' command of the Six Sigma methods at the relevant skill level (Green Belt, Black Belt etc.). Following this approach, many organizations in the 1990s started offering Six Sigma certifications to their employees. Criteria for Green Belt and Black Belt certification vary; some companies simply require participation in a course and a Six Sigma project. There is no standard certification body, and different certification services are offered by

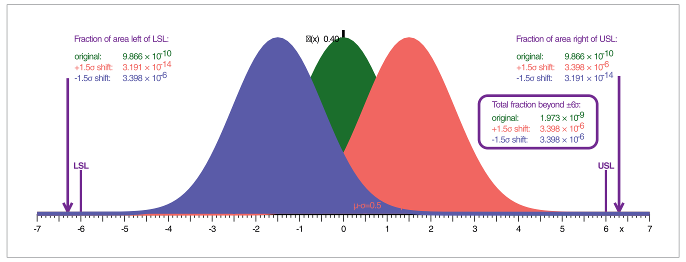
technical talk

various quality associations and other providers against a fee. The American Society for Quality for example requires Black Belt applicants to pass a written exam and to provide a signed affidavit stating that they have completed two projects or one project combined with three years' practical experience in the body of knowledge.

Etymology of "six sigma process"

The term "six sigma process" comes from the notion that if one has six standard deviations between the process mean and the nearest specification limit, as shown in the graph, practically no items will fail to meet specifications. This is based on the calculation method employed in process capability studies.

Capability studies measure the number of standard deviations between the process mean and the nearest specification limit in sigma units, represented by the Greek letter (sigma). As process standard deviation goes up, or the mean of the process moves away from the center of the tolerance, fewer standard deviations will fit between the mean and the nearest specification limit, decreasing the sigma number and increasing the likelihood of items outside specification. One should also note that calculation of Sigma levels for a process data is independent of the data being normally distributed. In one of the criticisms to Six Sigma, practitioners using this approach spend a lot of time transforming data from non-normal to normal using transformation techniques. It must be said that Sigma levels can be determined for process data that has evidence of non-normality.



Graph of the normal distribution, which underlies the statistical assumptions of the Six Sigma model. In the centre at 0, the Greek letter μ (mu) marks the mean, with the horizontal axis showing distance from the mean, marked in standard deviations and given the letter σ (sigma). The greater the standard deviation, the greater is the spread of values encountered. For the green curve shown above, μ = 0 and σ = 1. The upper and lower specification limits (marked USL and LSL) are at a distance of 6σ from the mean. Because of the properties of the normal distribution, values lying that far away from the mean are extremely unlikely: approximately 1 in a billion too low, and the same too high. Even if the mean were to move right or left by 1.5σ at some point in the future (1.5 sigma shift, coloured red and blue), there is still a good safety cushion. This is why Six Sigma aims to have processes where the mean is at least 6σ away from the nearest specification limit.

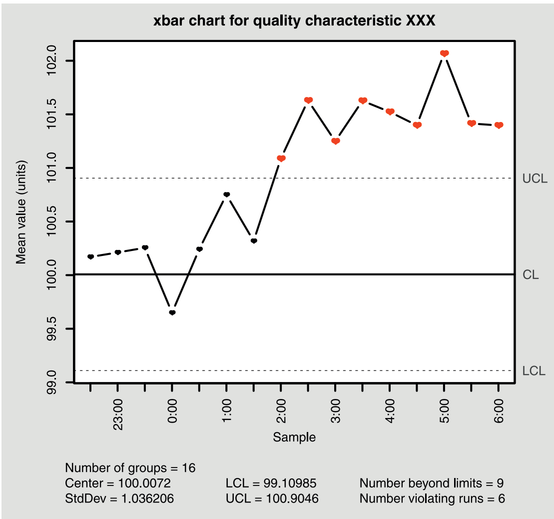
Role of the 1.5 sigma shift

Experience has shown that processes usually do not perform as well in the long term as they do in the short term. As a result, the number of sigmas that will fit between the process mean and the nearest specification limit may well drop over time, compared to an initial short-term study. To account for this real-life increase in process variation over time, an empirically based 1.5 sigma shift is introduced into the calculation. According to this idea, a process that fits 6 sigma between the process mean and the nearest specification limit in a short-term study will in the long term fit only 4.5 sigma – either because the process mean will move over time, or because the long-term standard deviation of the process will be greater than that observed in the short term, or both.

Hence the widely accepted definition of a six sigma process is a process that produces 3.4 defective parts per million opportunities (DPMO). This is based on the fact that a process that is normally distributed will have 3.4 parts per million outside the limits, when the limits are six sigma from the "original" mean of zero and the process mean is then shifted by 1.5 sigma (and therefore, the six sigma limits are no longer symmetrical about the mean). The former six sigma distribution, when under the effect of the 1.5 sigma shift, is commonly referred to as a 4.5 sigma process. However, it should be noted that the failure rate of a six sigma distribution with the mean shifted 1.5 sigma is not equivalent to the failure rate of a 4.5 sigma process with the mean centered on zero. This allows for the fact that special causes may result in a deterioration in process performance over time and is designed to prevent underestimation of the defect levels likely to be encountered in real-life operation.

The role of the sigma shift is mainly academic. The purpose of six sigma is to generate organizational performance improvement. It is up to the organization to determine, based on customer expectations, what the appropriate sigma level of a process is. The purpose of the sigma value is as a comparative figure to determine whether a process is improving, deteriorating, stagnant or non-competitive with others in the same business. Six sigma (3.4 DPMO) is not the goal of all processes.

Sigma levels



A control chart depicting a process that experienced a 1.5 sigma drift in the process mean toward the upper specification limit starting at midnight. Control charts are used to maintain 6 sigma quality by signaling when quality professionals should investigate a process to find and eliminate special-cause variation.

The table below gives long-term DPMO values corresponding to various short-term sigma levels.

These figures assume that the process mean will shift by 1.5 sigma toward the side with the critical specification limit. In other words, they assume that after the initial study determining the short-term sigma level, the long-term C_{pk} value will turn out to be 0.5 less than the short-term C_{pk} value. So, for example, the DPMO figure given for 1 sigma assumes that the long-term process mean will be 0.5 sigma beyond the specification limit (C_{pk} = –0.17), rather than 1 sigma within it, as it was in the short-term study (C_{pk} = 0.33). Note that the defect percentages indicate only defects exceeding the specification limit to which the process mean is nearest. Defects beyond the far specification limit are not included in the percentages.

The formula used here to calculate the DPMO is thus

Sigma level	Sigma (with 1.5σ shift)	DPMO	Percent defective	Percentage yield	Short-term C_{pk}	Long-term P_{pk}
1	−0.5	691,462	69%	31%	0.33	−0.17
2	0.5	308,538	31%	69%	0.67	0.17
3	1.5	66,807	6.7%	93.3%	1.00	0.5
4	2.5	6,210	0.62%	99.38%	1.33	0.83
5	3.5	233	0.023%	99.977%	1.67	1.17
6	**4.5**	**3.4**	**0.00034%**	**99.99966%**	**2.00**	**1.5**
7	5.5	0.019	0.0000019%	99.9999981%	2.33	1.83

Application

Six Sigma mostly finds application in large organizations. An important factor in the spread of Six Sigma was GE's 1998 announcement of $350 million in savings thanks to Six Sigma, a figure that later grew to more than $1 billion. According to industry consultants like Thomas Pyzdek and John Kullmann, companies with fewer than 500 employees are less suited to Six Sigma implementation or need to adapt the standard approach to make it work for them. Six Sigma however contains a large number of tools and techniques that work well in small to mid-size organizations. The fact that an organization is not big enough to be able to afford Black Belts does not diminish its abilities to make improvements using this set of tools and techniques. The infrastructure described as necessary to support Six Sigma is a result of the size of the organization rather than a requirement of Six Sigma itself.

Criticism

Lack of originality

Quality expert Joseph M. Juran described Six Sigma as "a basic version of quality improvement", stating that "there is nothing new there. It includes what we used to call facilitators. They've adopted more flamboyant terms, like belts with different colors. I think that concept has merit to set apart, to create specialists who can be very helpful. Again, that's not a new idea. The American Society for Quality long ago established certificates, such as for reliability engineers."

Inadequate for complex manufacturing

Quality expert Philip B. Crosby pointed out that the Six Sigma standard doesn't go far enough customers deserve defect-free products every time. For example, under the Six Sigma standard, semiconductors which require the flawless etching of millions of tiny circuits onto a single chip are all 100% unusable.

Role of consultants

The use of "Black Belts" as itinerant change agents has fostered an industry of training and certification. Critics have argued there is overselling of Six Sigma by too great a number of consulting firms, many of which claim expertise in Six Sigma when they have only a rudimentary understanding of the tools and techniques involved or the markets or industries in which they are acting.

Potential negative effects

A Fortune article stated that "of 58 large companies that have announced Six Sigma programs, 91 percent have trailed the S&P 500 since". The statement was attributed to "an analysis by Charles Holland of consulting firm Qualpro (which espouses a competing quality-improvement process)". The summary of the article is that Six Sigma is effective at what it is intended to do, but that it is "narrowly designed to fix an existing process" and does not help in "coming up with new products or disruptive technologies."

Over-reliance on statistical tools

A more direct criticism is the "rigid" nature of Six Sigma with its over-reliance on methods and tools. In most cases, more attention is paid to reducing variation and searching for any significant factors and less attention is paid to developing robustness in the first place (which can altogether eliminate the need for reducing variation). The extensive reliance on significance testing and use of multiple regression techniques increases the risk of making commonly unknown types of statistical errors or mistakes. A possible consequence of Six Sigma's array of P-value misconceptions is the false belief that the probability of a conclusion being in error can be calculated from the data in a single experiment without reference to external evidence or the plausibility of the underlying mechanism. One of the most serious but all-too-common misuses of inferential statistics is to take a model that was developed through exploratory model building and subject it to the same sorts of statistical tests that are used to validate a model that was specified in advance.

Another comment refers to the often mentioned Transfer Function, which seems to be a flawed theory if looked at in detail. Since significance tests were first popularized many objections have been voiced by prominent and respected statisticians. The volume of criticism and rebuttal has filled books with language seldom used in the scholarly debate of a dry subject. Much of the first criticism was already published more than 40 years ago. Refer to: Statistical hypothesis testing Criticism for details.

Articles featuring critics have appeared in the November-December 2006 issue of USA Army Logistician regarding Six-Sigma: "The dangers of a single paradigmatic orientation (in this case, that of technical rationality) can blind us to values associated with double-loop learning and the learning organization, adaptability, workforce creativity and development, humanizing the workplace, cultural awareness, and strategy making."

Nassim Nicholas Taleb considers risk managers little more than "blind users" of statistical tools and methods. He states that statistics is fundamentally incomplete as a field as it cannot predict the risk of rare events — something Six Sigma is specially concerned with. Furthermore, errors in prediction are likely to occur as a result of ignorance for or distinction between epistemic and other uncertainties. These errors are the biggest in time variant (reliability) related failures.

Stifling creativity in research environments

According to an article by John Dodge, editor in chief of Design News, use of Six Sigma is inappropriate in a research environment. Dodge states "excessive metrics, steps, measurements and Six Sigma's intense focus on reducing variability water down the discovery process. Under Six Sigma, the free-wheeling nature of brainstorming and the serendipitous side of discovery is stifled." He concludes "there's general agreement that freedom in basic or pure research is preferable while Six Sigma works best in incremental innovation when there's an expressed commercial goal."

A BusinessWeek article says that James McNerney's introduction of Six Sigma at 3M had the effect of stifling creativity and reports its removal from the research function. It cites two Wharton School professors who say that Six Sigma leads to incremental innovation at the expense of blue skies research. This phenomenon is further explored in the book Going Lean, which describes a related approach known as lean dynamics and provides data to show that Ford's "6 Sigma" program did little to change its fortunes.

Lack of systematic documentation

One criticism voiced by Yasar Jarrar and Andy Neely from the Cranfield School of Management's Centre for Business Performance is that while Six Sigma is a powerful approach, it can also unduly dominate an organization's culture; and they add that much of the Six Sigma literature – in a remarkable way (six-sigma claims to be evidence, scientifically based) – lacks academic rigor:

One final criticism, probably more to the Six Sigma literature than concepts, relates to the evidence for Six Sigma's success. So far, documented case studies using the Six Sigma methods are presented as the strongest evidence for its success. However, looking at these documented cases, and apart from a few that are detailed from the experience of leading organizations like GE and Motorola, most cases are not documented in a systemic or academic manner. In fact, the majority are case studies illustrated on websites, and are, at best, sketchy. They provide no mention of any specific Six Sigma methods that were used to resolve the problems. It has been argued that by relying on the Six Sigma criteria, management is lulled into the idea that something is being done about quality, whereas any resulting improvement is accidental (Latzko 1995). Thus, when looking at the evidence put forward for Six Sigma success, mostly by consultants and people with vested interests, the question that begs to be asked is: are we making a true improvement with Six Sigma methods or just getting skilled at telling stories? Everyone seems to believe that we are making true improvements, but there is some way to go to document these empirically and clarify the causal relations.

1.5 sigma shift

The statistician Donald J. Wheeler has dismissed the 1.5 sigma shift as "goofy" because of its arbitrary nature. Its universal applicability is seen as doubtful.

The 1.5 sigma shift has also become contentious because it results in stated "sigma levels" that reflect short-term rather than long-term performance: a process that has long-term defect levels corresponding to 4.5 sigma performance is, by Six Sigma convention, described as a "six sigma process." The accepted Six Sigma scoring system thus cannot be equated to actual normal distribution probabilities for the stated number of standard deviations, and this has been a key bone of contention over how Six Sigma measures are defined. The fact that it is rarely explained that a "6 sigma" process will have long-term defect rates corresponding to 4.5 sigma performance rather than actual 6 sigma performance has led several commentators to express the opinion that Six Sigma is a confidence trick.

Income Computation and Disclosure Standards (ICDS)

By Mr. Aniket Kulkarni
Chartered Accountant, Aniket Kulkarni & Associates

Section (S.) 145 of the Income-tax Act, 1961 (ITA) provides that taxable income of an assessee falling under the heads "Profits and gains of business or profession" or "Income from other sources", shall be computed in accordance with either cash or mercantile system of accounting which is regularly employed by the assessee. It further provides that the Central Government (CG) may notify, from time-to-time, Income Computation & Disclosure Standards (ICDS) to be followed by any class of taxpayers or in respect of any class of income. Revised ICDS shall apply from AY 2017-18 onwards

The CG vide notification dated 31st March, 2015 has notified 10 ICDS for compliance by all assessees following mercantile system of accounting w.e.f. 1st April, 2015. These ICDS supersede following two standards notified in 1996:

a. Tax Standard I – Disclosure of accounting policies

b. Tax Standard II – Disclosure of prior period and extraordinary items and changes in accounting policies

Certain key highlights of ICDS, amendments carried out in Finance Act, 2015 at enactment stage and differences between ICDS and existing Accounting Standards (AS) are discussed hereunder:

I. Following are key highlights of notified ICDS

- ICDS shall apply for computation of income chargeable to income-tax under the head "Profits and gains of business or profession" or "Income from other sources". Accordingly, ICDS has no impact on minimum alternate tax computation for corporate assessees which will continue to be based on 'book profit' determined in accordance with currently applicable AS.
- ICDS is applicable to all taxpayers (corporates/non-corporate or resident/non-resident) irrespective of turnover or quantum of income.
- The preamble of each ICDS clarifies that (a) ICDS is applicable for computation of income and not for the purposes of maintenance of books of account; and (b) In case of conflict between the provisions of ITA and ICDS, the provisions of ITA shall prevail to that extent.
- Non-compliance of ICDS empowers Tax Authority to assess income on 'best judgment' basis. Any additions to income declared in return of income may also have potential penalty implications.
- Unlike AS, ICDS does not provide any explanations or illustrations but merely prescribes main principles to be adopted while computing income.
- Following is the list of 10 ICDS notified w.e.f. 1st April, 2015 :

ICDS

- Accounting policies (ICDS I)
- Valuation of inventories (ICDS II)
- Construction contracts (ICDS III)
- Revenue recognition (ICDS IV)
- Tangible fixed assets (ICDS V)
- Effects of changes in foreign exchange rates (ICDS VI)
- Government grants (ICDS VII)
- Securities (ICDS VIII)
- Borrowing costs (ICDS IX)
- Provisions, contingent liabilities and contingent assets (ICDS X)

Comparable AS

- Disclosure of Accounting Policies (AS 1)
- Valuation of Inventories (AS 2)
- Construction Contracts (AS 7)
- Revenue Recognition (AS 9)
- Accounting for Fixed Assets (AS 10)
- The Effects of Changes in Foreign Exchange Rates (AS 11)
- Accounting for Government Grants (AS 12)
- Accounting for Investments (AS 13)
- Borrowing Costs (AS 16)
- Provisions, Contingent Liabilities and Contingent Assets (AS 29)

• The following proposed ICDS for which drafts were circulated have not yet been notified:

1. Events occurring after the end of previous year
2. Prior period expense
3. Leases
4. Intangible Assets

II. Amendments to Finance Act, 2015 in order to align ITA with ICDS

Finance Minister presented Finance Act 2015, as part of Union Budget 2015-16, to Parliament on 28th February, 2015. Certain provisions of ICDS did not align with provisions of the ITA and thus, Finance Act 2015 was amended (amended Finance Act) and at the enactment stage in Lok Sabha following modifications to existing provisions of ITA were introduced:

a. ICDS on Government Grants – So far as government grants related to acquisition of depreciable assets, both AS and ICDS provide for recognition of such grants either by way of reduction from cost of depreciable asset or as income over the periods necessary to match with the related costs.

However, treatment of recognising grants for non-depreciable assets as per AS and ICDS were not in sync. There was ambiguity or conflict of ICDS with ITA when it required recognition of a grant which is related to non-depreciable asset of capital nature, as assessees income.

The amended Finance Act proposes to amend the definition of 'income' under s.2(24) of ITA to include any assistance in the form of a subsidy or grant or cash incentive or duty drawback or waiver or concession or reimbursement (by whatever name called) by the CG or State Government or any authority or body or agency, in cash or kind, to the assessee. However, subsidy / grant / reimbursement which is taken into account for determination of 'actual cost' of depreciable assets in accordance with the provisions of Explanation 10 to s.43(1) shall not be treated as income.

b. ICDS on Borrowing costs – ICDS IX relating Borrowing costs provides for capitalisation of borrowing costs in respect of qualifying assets viz. tangible/intangible assets and inventories . ITA provides for deduction in respect of all borrowing costs except when they are incurred for acquisition of an asset 'for extension of existing business or profession'. The condition of acquisition of asset 'for extension of existing business or profession' for disallowance of borrowing costs under the ITA was in conflict with ICDS since ICDS does not have this condition.

The amended Act proposes to omit the condition of asset acquisition 'for extension of existing business or profession' for disallowance of borrowing cost to align the provisions of ITA with ICDS.

c. ICDS on Revenue recognition and Provisions, contingent liabilities and contingent assets – Application of some ICDS like Revenue Recognition or Provisions, Contingent Liabilities and Contingent assets may have resulted in accelerated recognition of income for tax purposes though the same may not be recorded in books of account as per applicable AS. It is possible that such income may eventually be found to be irrecoverable. While the ITA provides bad debt deduction for debts which are written off as irrecoverable in accounts, it would be difficult to claim bad debt deduction for income which is irrecoverable but hitherto not recognised in the books.

In order to remove this anomaly, the amended Finance Act provides that such debt taxed as per ICDS but not recognised in the books shall be allowed as bad debt in the previous year in which it becomes irrecoverable and it shall be deemed as if such debt has been written off as irrecoverable in the accounts of assessee for this purpose.

III. Comparison of ICDS with comparable AS

While ICDS have been broadly framed in accordance with comparable AS, following are certain deviations/carve outs in comparison with existing AS:

Readers are required to note the following before giving effect to the provisions provided in ICDS while computing income for the purpose of ITA:

1. In case of conflict between the provisions of the ITA and ICDS, the provisions of ITA shall prevail to that extent. Issue requiring examination is whether the same position would prevail in case of conflict between SC/HC rulings and ICDS
2. Whether method of accounting u/s 145 can enlarge/reduce scope and ambit of income u/s.4 and 5 r.w s.2(24)? (Refer note 1)
3. Impact of rulings rendered pre-ICDS which are in cross roads to ICDS needs to be evaluated by readers

Caption	AS	ICDS
AS 1 vs. ICDS I – Accounting policies		
Concept of Prudence modified	Provision is made for all known liabilities and losses on best estimate basis	Marked to market (MTM) loss or an expected loss shall not be recognised unless permitted by any other ICDS
	Anticipated profits are not recognised	ICDS silent on recognition of anticipated profits
Materiality omitted	Materiality should be considered while selecting and applying accounting policy	Concept of Materiality not recognised in ICDS
Change in accounting policy	Change in accounting policy permitted if (a) required by statute; (b) required for compliance of AS; (c) change results in more appropriate presentation of financial statements	Accounting policies shall not be changed without a "reasonable cause"
Disclosure of change in accounting policy	Required in period of change, if impact is not material in current period but material in later periods	Required in period of change and also required in first year in which change has material effect, if impact is not material in current period but material in later periods
AS 2 vs. ICDS II – Valuation of inventories		
Valuation of service inventory	No specific provision	Valuation at cost8 or net realisable value (NRV), whichever is lower
Omission of standard cost method	Inventory valuation methods are (a) first-in, first-out (FIFO); (b) weighted average cost formula; (c) specific identification; (d) retail method; (e) standard cost method	Inventory valuation methods are (a) FIFO; (b) weighted average cost formula; (c) specific identification; (d) retail method
Opening inventory	No specific provision	• Value of opening inventory of a business shall be the same as the value of inventory at the end of the immediately preceding financial year • In case of commencement of business, Cost of inventory on the day of commencement of business will be opening inventory
Change in method of inventory valuation	Change permitted if (a) required by statute; (b) required for compliance of AS; (c) change results in more appropriate presentation of financial statements	Method of valuation once adopted shall not be changed without "reasonable cause"
Inventory valuation in case of certain dissolutions	No specific provision	In case of partnership firm, AOP or BOI inventory on the date of dissolution shall be valued at NRV, whether or not business is discontinued
AS 7 vs. ICDS III – Construction contracts		
Recognition of contract revenue	Contract revenue to be recognised if it is possible to reliably measure the outcome of a contract	• The criteria of 'reliable measurement of outcome of contract' omitted • ICDS requires recognition if there is reasonable certainty of its ultimate collection
AS 7 vs. ICDS III – Construction contracts		
Retention money	Silent on treatment of accrual of income	Retention money to be considered as part of contract revenue and revenue to be recognised on POCM basis

Allowability of losses including probable / expected loss	Losses fully allowable irrespective of commencement, stage of completion and expected profits from other independent contracts	• Losses not allowable unless actually incurred and only on POCM basis • ICDS on accounting policies also does not permit recognition of foreseeable loss
Contract Work in progress recognition	Contract cost which relate to future activity shall be recognised as an asset only if recoverability is probable	Contract cost to be recognised as an asset
Early stage of contract - Non- recognition of revenue	• Revenue to be recognised only to the extent of recoverable costs • No profit to be recognised during early stages of contract	Same as AS, however ICDS objectively defines early stage as not to exceed beyond 25%
Pre-construction incidental income	Contract cost may be reduced by any incidental income that is not included in contract revenue	Contract cost shall be reduced by any incidental income (except interest, dividend and capital gains) that is not included in contract revenue
AS 9 vs. ICDS IV – Revenue recognition		
Postponement of revenue recognition	Revenue recognition to be postponed if significant uncertainty exists on measurability and collectability of revenue from sale of goods, rendering of services, interest, royalties and dividends	Revenue to be recognised only if there is reasonable certainty of its ultimate collection from sale of goods and rendering of services
Method of revenue recognition for service contracts	• Proportionate completion method or • Completed service contract method	• Mandatory to recognise revenue based on POCM • ICDS requires application of ICDS III on Construction contracts for recognition of such revenue on mutatis mutandis basis.
Disclosure requirement	Disclose circumstances in which revenue recognition has been postponed pending significant uncertainties.	Disclosures for amounts not recognised as revenue due to lack of reasonable certainty of its ultimate collection along with nature of uncertainty
AS 10 vs. ICDS V – Tangible fixed assets		
Applicability	Fixed assets such as land, building, plant and machinery, vehicles, furniture and fittings, goodwill, patents, trademarks and designs	Tangible fixed assets being land, building, machinery, plant or furniture
Component of cost	'Cost' of fixed asset comprises its purchase price, non- refundable taxes and any directly attributable cost of bringing the asset to its working condition for its intended use. Trade discount and rebates will be deducted while computing cost.	It has similar definition to AS 10 but words used are 'actual cost' as compared to 'cost' in AS 10
Stand-by equipment and servicing equipment	AS acknowledges capitalisation of stand-by equipment and servicing equipment as a normal practice but does not mandate it	ICDS 'mandates' capitalisation of stand-by equipment and servicing equipment
Machinery spares	• It is 'usually' charged to P&L a/c on consumption. • However, if spares are used only in connection with the item of fixed asset with irregular use then it 'may' be appropriate to capitalise	• It 'shall' be charged to P&L a/c on consumption • However, if spares are used only in connection with the item of fixed asset with irregular use then it 'shall' be capitalised

Asset acquired against non-monetary consideration	In case of acquisition of fixed asset in exchange for another asset, shares or other securities issued, cost of asset acquired should be recorded either at (a) fair market value of asset given up/shares or securities issued or (b) fair market value of asset acquired, whichever is more clearly evident	In case of acquisition of a tangible fixed asset in exchange for another asset, shares or other securities issued, actual cost of the tangible fixed asset shall be recorded at fair value of tangible fixed asset acquired
Assets acquired for consolidated price	Consolidated price to be apportioned to various assets on a fair basis as determined by competent valuers	Consolidated price shall be apportioned to various assets on a fair basis
Disclosure requirement	Gross and net book values at beginning and end of year showing additions, deletions and other movements, expenditure incurred in course of construction and revalued amount, if any	Description of assets/block of assets, depreciation rate and allowable depreciation, actual cost / opening WDV and closing WDV showing additions or deduction including adjustment for CENVAT, exchange difference and subsidy, grant or reimbursement
AS 11 vs. ICDS VI – Effects of changes in foreign exchange rates		
Revenue monetary items (like trade receivables, payables)	• Converted into reporting currency by applying the closing rate • Exchange difference recognised in P&L a/c	• Converted into reporting currency by applying the closing rate • Exchange difference recognised as income or expense subject to provisions of Rule 115
Revenue non-monetary items (e.g. Inventory)	If item is carried at historical cost – Reported at the exchange rate on the date of transaction If item is carried at fair value – Reported at the exchange rate that existed when the value was determined	Converted into reporting currency using the exchange rate at the date of the transaction
Capital monetary items – Relating to Imported assets and domestic assets	• Requires recognition in P&L A/c • Option of capitalisation u/s. 211(3C) of Cos Act, 1956 as per which exchange differences arising in case of long-term foreign currency monetary items shall be either adjusted to capital asset or accumulated in FCMITDA (Paras 46 & 46A)	• Requires recognition as income or expense subject to provisions of s.43A15 • No paras 46 and 46A exists • No distinction recognised between capital and revenue items
Foreign operations	Foreign operation is a subsidiary, associate, joint venture or branch of the reporting enterprise, the activities of which are based or conducted in a country other than the country of the reporting enterprise	Foreign operations of a person is a branch, by whatever name called, of that person, the activities of which are based or conducted in a country other than India
Integral foreign operation	• Same principles as for own assets and liabilities • Exchange differences are recognized in P&L A/c	• Subject to S. 43A and Rule 115, similar to AS 11 • No distinction recognised between capital and revenue items
Non-integral foreign operations	• All assets & liabilities and income & expense items are translated at closing rates • Exchange differences are accumulated in FCTR16 A/c and to be taken to P&L a/c on disposal of non-integral foreign operations	• Similar to ICAI AS-11 except that, (subject to S.43A & Rule 115) resulting exchange differences are to be recognized as income or expense instead of accumulation in FCTR A/c • No distinction recognised between capital and revenue items

Forex derivatives for hedging purpose (Capital and revenue a/c)	• Premium/discount is amortized over life of contract • Restated on MTM basis at year end and difference is recognized in P&L • Profit/loss on cancellation or renewal is also recognized in P&L	Same as AS without distinguishing between contracts on capital account and revenue account (subject to s.43A applicable to imported assets)
Forex derivative for trading / speculation purposes / firm commitments /highly probable forecast transactions	• Forward contract is restated at year end on mark to market basis and difference is recognized in P&L • No amortization of premium/discount	• Premium, discount or exchange difference shall be recognised at the time of settlement • No distinction recognised between contracts on capital account and revenue account
Forex derivatives not covered by ICDS VI (futures, interest rate swaps, etc)	• Not covered by AS 11 being a derivative contract covered by AS 30, 31 & 32 which are yet to be notified under Companies Act 2013 • Currently ICAI Guidance Note requires recognition of loss on MTM basis but gain to be ignored	• Forex derivatives not covered by ICDS VI. • ICDS I on accounting policies provides that MTM loss or an expected loss shall not be recognized unless permitted under other ICDS.
AS 12 v. ICDS VII - Government grants		
Recognition of grant	• On reasonable assurance of compliance of attached conditions and reasonable certainty of ultimate collection • Mere receipt of grant is not sufficient	• On reasonable assurance of compliance of attached conditions and reasonable certainty of ultimate collection • Recognition cannot be postponed beyond date of actual receipt
Grant in the nature of promoters contribution	To be credited to capital reserve and to be treated as shareholders' funds	ICDS silent on this category17 Refer discussion at para II(a)
Grants relatable to depreciable fixed assets	To be reduced from cost or recognised as deferred revenue by systematic credit to P&L A/c	To be reduced from cost of fixed asset [in line with Explanation 10 to S. 43(1)]
Relatable to non-depreciable fixed assets	• To be credited as capital reserve, if no conditions attached to the grant • To be credited to P&L A/c over period of incurring cost of meeting conditions of grant	• To be considered as income on an upfront basis, if there are no conditions attached to grant [Refer discussion at para II(a)] • To be treated as income over period over which cost of meeting conditions is incurred
Grants other than those covered above	Revenue grant to be credited as income or reduced from related expense	Grant to be treated as income over period over which cost of meeting conditions is incurred. [Refer discussion at para II(a)]
Compensation for expenses / loss incurred or for giving immediate financial support	To be recognised as income in the year in which it is receivable	To be recognised as income in the year in which it is receivable
Disclosure requirement	Accounting policy adopted for grants including the method of presentation, extent of recognition in the financial statements, accounting of non-monetary assets given at concession/free of cost	Requires disclosure of nature and extent of recognised as well as unrecognized grants. It also requires disclosure of reasons for non-recognition.

AS 13 vs. ICDS VIII – Securities		
Applicability	• AS applicable to accounting for investments • AS clarifies that principles applicable to 'current investments' can apply to securities held as stock-in-trade	• ICDS applicable to securities held as stock-in-trade19 • 'Securities' defined to have meaning assigned in S.2(h) of SCRA20 except derivatives referred in s.2(h)(1a) of SCRA
Security acquired against non-monetary consider-ation	In case of acquisition of securities in exchange for shares or other securities issued or another asset, cost of security acquired should be recorded either at (a) fair market value of securities issued or (b) fair market value of asset given up, whichever is more clearly evident	In case of acquisition of securities in exchange for other securities issued or another asset, actual cost of security acquired shall be recorded at fair value of security acquired
Year-end valuation of securities	Current investments to be valued at lower of cost or fair value either on individual investment basis or by category of investment but not on global basis.	• Securities should be valued at lower of cost or NRV. Comparison of cost and NRV shall be done category-wise. • Securities are classified under following categories (a) shares; (b) debt; (c) convertible securities; and (d) other securities
Opening value of securities	No specific provision	• Value of opening inventory of securities shall be the same as the value of securities at the end of the immediately preceding financial year • In case of commencement of business, Cost of security on the day of commencement of business will be opening value
Valuation of unlisted or thinly traded securities	No specific provision	Valuation of unlisted or thinly traded securities shall be valued at actual cost initially recognised
Ascertainment of cost	Cost formulae are the same as those specified in AS 2 (e.g. FIFO; average cost, etc.)	Cost which cannot be ascertained by specific identification shall be determined on the basis of FIFO method.
Ascertainment of cost	Cost formulae are the same as those specified in AS 2 (e.g. FIFO; average cost, etc.)	Cost which cannot be ascertained by specific identification shall be determined on the basis of FIFO method.
AS 16 vs. ICDS IX – Borrowing costs		
Borrowing cost	Borrowing cost includes exchange difference to the extent that they are regarded as an adjustment to interest costs	Borrowing cost does not include exchange differences arising from foreign currency borrowings
Qualifying assets	Qualifying asset defined to be an asset which necessarily takes a substantial, period of time to get ready for its intended use or sale	Qualifying assets means Inventory that require a period of 12 months or more to bring them to a saleable condition Specified tangible and intangible assets are qualifying assets (regardless of substantial period condition)

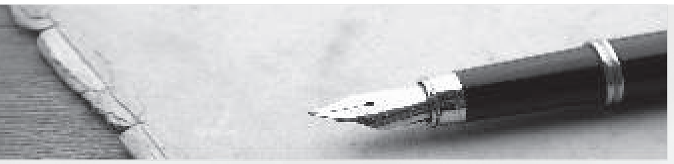
Commencement and cessation of capitalisation	In case of specific borrowing	
	Capitalisation will commence when all the three conditions are satisfied (a) incurrence of capital expenditure (b) incurrence of borrowing cost (c) construction activity is in progress and cessation from the date when asset is ready to use	Capitalisation will commence from date of borrowing of funds and cessation from the date when asset is put to use
	Capitalisation will commence when all the three conditions are satisfied (a) incurrence of capital expenditure (b) incurrence of borrowing cost (c) construction activity is in progress and cessation from the date when asset is ready to use	Capitalisation will commence from date of borrowing of funds and cessation from the date when asset is put to use
	In case of specific borrowing	
	Same as in the case of specific borrowing	Capitalisation will commence from date of utilisation of funds and cessation from the date when asset is put to use
Methodology of capitalisation	In case of specific borrowing	
	Directly attributable to borrowing cost	Directly attributable to borrowing cost
	In case of general borrowing	
	Weighted average cost of borrowing applied to capital expenditure	Prorate borrowing cost allocation as per normative formulae (Refer note 2)
Income from temporary deployment of funds	Income from temporary deployment of unutilised funds from specific loans to be reduced from borrowing cost	No similar provision in ICDS
Suspension of capitaliza-tion	Capitalisation of borrowing costs should be suspended during extended periods in which active development is interrupted	No similar provision in ICDS
AS 29 v. ICDS X - Provisions, contingent liabilities and contingent assets		
Onerous executory contracts	• Includes onerous executory contracts within its scope • Upfront recognition of liabilities required under onerous contracts	Onerous executory contracts excluded from the scope of ICDS
Recognition of provision	• Provision shall be recognized when it is "probable" that an outflow of economic resources will be required to settle an obligation • Provision is not discounted to NPV	• Provision shall be recognised when it is "reasonably certain" that an outflow of economic resources will be required to settle an obligation • Provision is not discounted to NPV
Recognition of contingent asset and reimbursement claims	Contingent asset / reimbursement claims are recognised when the realization of related income is "virtually certain"	Contingent asset/reimbursement claims are recognised when the realisation of related income is "reasonably certain"
Meaning of obligation	Clarifies that obligations may be legally enforce-able and may also arise from normal business practice, custom and a desire to maintain good business relations or act in an equitable manner.	No specific guidance on meaning of 'obligation

Welcome NEW MEMBER

PPMAI welcome the following member/s who newly joined the Association and look forward to their prolonged association and active participation in all our programmes.

Sr. No.	Name of the company	Name of the company	Activity
1.	**HEMALATHA HI-TECH INDUSTRIES** No.67-73, Vallalar Nagar, SIPCOT, Cuddalore – 607005. Tamilnadu. Tel: 04142 – 239688 Fax: 04142 – 239788 Email: hemalathaahitech@yahoo.com Web: www.hemalathaahitech.com	**Mr. Shakthi Ganapathy** Managing Partner **Mr. Senthil Bharathy** Partner Mob: 09362237258	manufacturer Manufacturers of Process Equipment like Tanks, Heat exchangers, Pressure vessels, Columns/Towers, Reactors, Vacuum Chambers, Double Cone Blenders, Filters, Separators, Evaporators, Dairy Equipment etc. Turnkey Projects, EPC, MS & SS Piping Works, Structural Works etc. Installation & Commissioning of Equipment, Site Fabrication etc.

Words of WISDOM



- When you are tempted to get angry and feel frustrated with those around you, take a moment to think about your own faults and shortcomings. This will help you to be patient with other.
- If you talk to a man in a language he understands, that goes to his head. If you talk to him in his language, that goes to his heart.
- Contentment is a feeling that envelops you when you are truly thankful for what you have and are no longer seeking to acquire more.
- Enthusiasm is the fuel of life; it helps you to get where you are going.
- It is not always what you say that makes the difference; sometimes it is the way you say it.
- Let us look behind us with understanding, before us with faith, and around us with love.
- One good thing about mistakes is that they help you be more patient with others. How can you criticize others for their faults when you know you have got plenty of your own?
- Trying times need not drag you down if you will see them as doorways to new beginnings.
- It is better to complete a small project than to leave a big one half done.
- There is always some good in every situation; all you have to do is look for it.
- If you can't see the stars twinkle in the night sky, it doesn't mean that they have disappeared. They are just behind a blanket of clouds and you will see them shine again.
- Don't knock the benefits of relaxation. A refreshed soul can be a truly creative soul, and a truly creative soul is a productive soul.
- To bring out the best in those around you, give them encouragement and show them loving appreciation.

ADVERTISEMENT **TARIFF**

PPMAI Speak Bi-Monthly Bulletin

Full Page Colour	Amount
Back Cover Outside / Inside	₹ 25,000.00
Inside Front Cover	₹ 25,000.00
Inside Full Page	₹ 20,000.00

Specification of our publication is as follows:

Period : Bi-monthly
Print Size : A-4
Print Process : Offset 4 colour
Paper used for cover : 170 gsm Sinarmass Coated Art Paper with matte lamination
Paper used for inside : 130 gsm Sinarmass Coated Art Paper

Advt. Size Artwork should be A/4 size for full page advt. (210 mm width x 297 mm height). All advertisement will be in 4+4 cmyk Colours.

Payment:

- Payment for banner advertisement should be made in advance by Cheque / DD in the favour of, "Process Plant and Machinery Association of India" payable at Mumbai along with release order

PPMAI Website

Internet today has made the world small place and easily reachable nay it is the best and fastest medium to reach and access global markets. Airing advertisements on website is definitely an economical way to propagate your company and publicize your products world-over. Keeping this in mind, we have earmarked seven strips for advertisements on our website.

www.ppmai.org
gives you an opportunity to advertise worldwide

We are pleased to inform you that PPMAI website www.ppmai.org is now fully revamped with new look and features.

₹ 10,000/- per annum
(exclusive of service tax)

Advertisers may modify their advertisement matter every quarter.

- The rate includes free link to your existing website
- The banner will be designed and provided by the advertiser as per specified size
- The banner will be in the form of JPEG or GIF file and its size will not exceed 20kB

Payment:

- Payment for banner advertisement should be made in advance by Cheque / DD in the favour of, "Process Plant and Machinery Association of India" payable at Mumbai along with release order

PPMAI eSpeak Journal | soft copy (Published twice in a month)

₹ 10,000/- per annum
(Rupees : Ten Thousand per annum)

- Advertisers may change their advertisement matter every quarter
- The rates quoted are exclusive of service tax
- The size of the ad should be around 40 kb max. Logos or Images will not be entertained
- A format will be provided by PPMAI wherein the advertiser can furnish the advertisement matter

Payment:

- Payment for banner advertisement should be made in advance by Cheque / DD in the favour of, "Process Plant and Machinery Association of India" payable at Mumbai along with release order

PPMAI Newsletter | soft copy (Published twice in a month)

₹ 10,000/- per annum
(Rupees : Ten Thousand per annum)

- Advertisers may change their advertisement matter every quarter
- The rates quoted are exclusive of service tax.
- The size of the ad should be around 40 kb max. Logos or Images will not be entertained.
- A format will be provided by PPMAI wherein the advertiser can furnish the advertisement matter.

Payment:

- Payment for banner advertisement should be made in advance by Cheque / DD in the favour of, "Process Plant and Machinery Association of India" payable at Mumbai along with release order

For enquiries and queries contact :

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