INNOVATION IN VALVES – NEED OF THE HOUR

Commodore Dr RK Rana &
Commander Neeraj Chawla

INTRODUCTION

1. The projected increase in national GDP, coupled with increased globalization and acceptance of India with main stream of industrial economies, has invigorated the industrial sector across the entire spectrum, be it in automobiles, ship building, aerospace, chemicals, offshore, refineries etc. Consistent with the projected economic growth and maritime interests, the Indian Navy and the Indian Coast Guard are also poised to grow with a well defined warship production and acquisition schedule [1], as per the Maritime Capability Perspective Plan, with the majority of weapon platform being indigenously designed and built ranging from a Seaward Defence Boat to an Aircraft Carrier.
2. Any ship can be divided into three main functional group viz – to Float; to Move and to carry the payload. Whilst the first two are common for all ships, it is the payload, where there is a distinct difference. A warship's payload being variety of weapons and sensors, thus making it one of the most complex system engineering exercises during their design and building.
3. Amongst the variety of different system that exist onboard ships, the fluid systems represent a vital link within the complex assembly of platform sub-system responsible for transferring a varying array of fluid medium from the service provider to end user. Many critical types of equipment rely considerably on supporting fluid systems in order to function effectively and valves are intrinsic part of these fluid system, performing variety of function from isolating to controlling the fluids.
4. Much of the technology used by Indian industry is globally sourced and internal R & D for developing technology has been minimal. This is reflected by gross expenditure in R & D, which was around 0.7% of GDP out of which business R & D accounts for only about 20% as against Government spending of more than 75% in 2007-08. India has spent 0.88% of GDP against 1.42% of Brazil and China [2]. Considering the overall requirements of valves in the entire spectrum of industries, there is a case for a focused approach on development of valves through innovation and R & D to make India self reliance, through which the Indian Navy will also derive maximum benefits.
5. The authors, through this paper, therefore wish to share their thoughts on the approach that would be essential to maximise self reliance in the valves sector using innovative methods with the help of the resources of the Indian industry.

Dr. R.K. Rana addressing the CII Conference

OPPORTUNITIES

6. The valves form one of the largest number of fittings across the ship, with a wide range of sizes, types, functions etc and therefore poses its own set of challenges not only in their selection during the design stage but also during the lifetime and subsequent stocking up as spares. For any ship irrespective of the size and role there are a few basic ship systems, which are present in all ships, as they provide the minimum capability for the ship to keep afloat and provide the required mobility. These are sea water, fuel, lubricating oil, chilled water, fresh water systems etc. As the ship size and displacement grow, the spread of these system increases, thereby proportionately enhancing the quantity of valves required. The following table gives an idea of the representative quantity of valves that may be required in different classes of ships [3].

S. No	Type of valves
(a)	Ball
(b)	Butterfly
(c)	Gate
(d)	Globe
(e)	Swing Check
(f)	SDNR
(g)	Control

S. No.	Class of Ship	Quantity
(a)	Corvette	~700
(b)	Frigate	~1100
(c)	Destroyer	~1500
(d)	Aircraft Carrier	~6000

7. Though all types of valves as shown in Figure 1[4], are found onboard warships, right from a simple sampling cock of 10 mm nominal bore to 12" gate valves, the majority of relatively low pressure valves that are commonly found are indicated in the table below, that may have flanged or screwed end connection [4].

8. **Legacy Ships.** In addition to the requirement of valves for the new ships being constructed or planned to be inducted, there is a large requirement to replace the valves on legacy ships procured from Russia, UK, Poland, USA etc, as and when, they become beyond economical repairs. In majority of cases, the challenge is non availability of detailed drawings and specifications of the material. An effort is already on with M/s NFTDC, Hyderabad to capture the geometrical details establishing the original material and generation of production drawings so that these valves can be productionised by one of the many valve manufacturers. A sample of the drawing (2D and 3D) generated is shown in Figure 2 (A, B and C)[5]. As the volumes are large, the Indian industry's help is solicited to generate these drawings at base ports or onboard ships directly if possible.

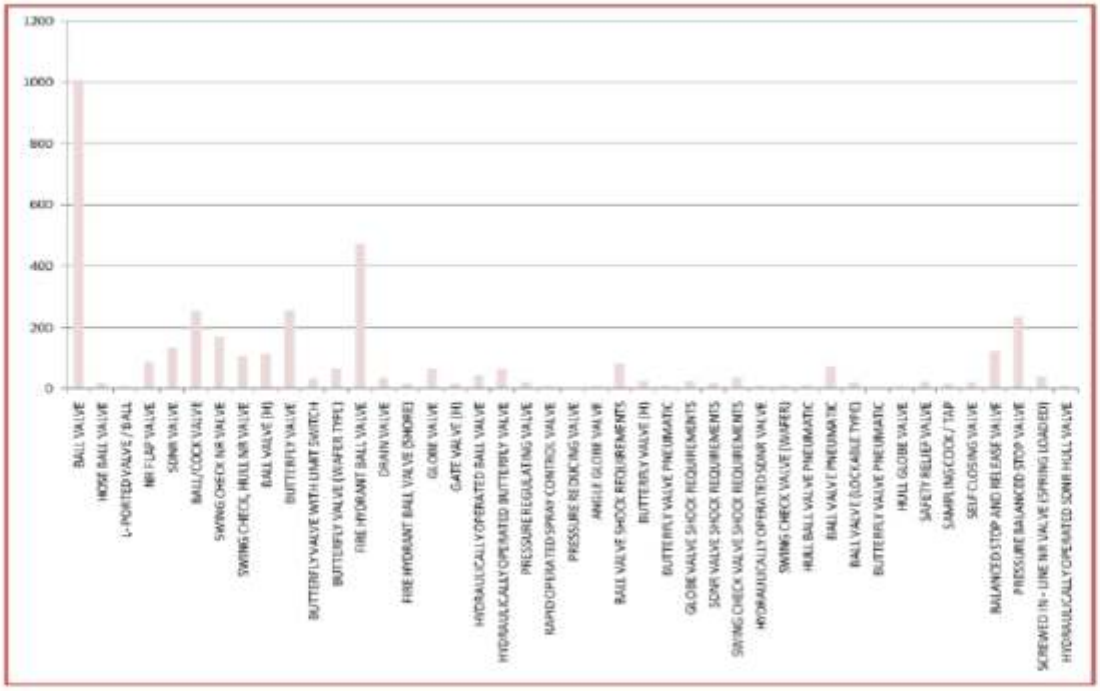


Fig 1 Quantity of Different Valves in a Typical Warship

SPECIAL REQUIREMENT FOR NAVAL VALVES

9. Whilst any valve used in the commercial field will satisfy the functional requirements, they

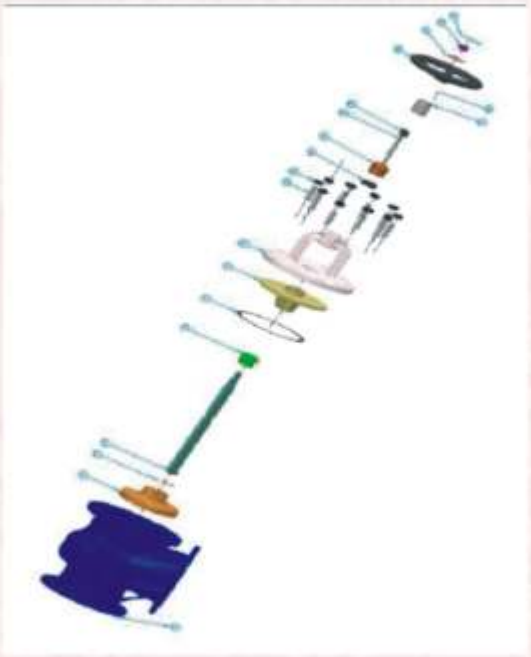
GEC

GENERAL ENGINEERING CONSORTIUM

Features of GEC Valves

- Valves manufactured & tested as per BS/APL std.
- Firesafe design valves for LPG/HSD/Solvents
- Metal Seated Valves for high temp/Abrasion Appln.
- Cryogenic Valves for low temperature
- Flush Bottom Valves for Hydrogenators
- Flush Bottom/Ball/RAM & Plug Type Design for Reaction Vessels
- 3 Way Ball Valves for Filters and Coolers
- Valves for Lube Oil Systems
- Valves for Cleanroom Applications
- Valves for Pharmaceuticals / Bulk Drugs & Heavy Chemicals
- Valves for HVAC Applications
- Valves for Engine Room Applications
- Valves for ETP & DM Water Applications
- Pneumatic Actuated Ball/ Butterfly & Flush Bottom Valves.

5,18th Cross, Kanakanagar, R.T. Nagar Post, Bangalore 560 032. Ph.: 080 23541808, 65607867, 42007662
Telefax: 080 23541808 E-mail: gec1@vsnl.com Website: www.gecvalves.com



have to be tailored to meet the special requirements imposed by the marine and warship environment, so that the valve can perform its role efficiently over a long period of time. Combined with the reduction in manpower available to man the ship, these valves have to be interfaced to the Integrated Platform Management System, so that either they can be operated automatically with certain intelligence built in or operated remotely with electric, electro-hydraulic or electro-pneumatic actuation mechanism.

S.No.	System	Pre Rating	Material			
			Body	Disc	Seat	Stem
(a)	Sea Water	10 bar	NAB	NAB	NAB	NAB
(b)	Lube Oil	10 bar	Gunmetal	NAB	NAB	NAB
(c)	Chilled Water	10 bar	Gunmetal	Gunmetal	Gunmetal	NAB
(d)	Fire Main	16 bar	NAB	NAB	NAB	NAB
(e)	Fresh Water	16 bar	Gunmetal	Gunmetal	Gunmetal	HT Al Bronze
(f)	Fuel	16 bar	Cast Steel	Stainless Steel	Stainless Steel +PTFE	Stainless Steel

With the field experience gained so far, Navy has homed on to the specific type of material for construction of valves. A representative list, along with the pressure rating, of valve material in different system is indicated in the table below. Other than firemain, fuel and fresh water system valves which have a pressure rating of 16 bar, all the other systems have a minimum rating of 10 bar, even though the working pressure in the system is not more than 3 bar. The material of construction of all the seawater systems valves have been specified as Nickel Aluminum Bronze (NAB) [3].

10. **Fire Safe.** In order to minimize the risk of fire due to leakage of fluid, fire safe valves are a necessary condition, when specifying valves for fuel systems, as these system pipes may pass through machinery spaces where overall localized temperature may be high.

11. **Shock.** The warships are designed to operate even when exposed to limited shock from the underwater detonations and hence depending on the criticality of the system and their location in the ships, the valves are generally either shock graded or without any shock grading. The shock grade curves define the severity of shock from where the parameters such as shock acceleration, velocity pulse duration, time to reach maximum shock velocity are derived. These can then be used for designing the valves and their actuators for inherently withstanding the shock values derived from the shock curves. The valves are classified into three categories, viz, NSSII, Shock Grade curve A and non shock grade. These require specific tests to be carried out prior to their certification.

12. **Noise.** Warships have to be designed to be as silent as is physically realizable so as to ensure that the enemy ships are not able to track the ship and also ship's own sonar work more efficiently due to low self noise generation. The machinery therefore installed onboard warships is so designed or special isolating mechanisms installed, so that the noise transmitted from them is minimized/ eliminated.

13. Though a valve is a very small fitting, the turbulence of flow combined with the cavitation noise due to collapse of vapour particles in the liquid due to pressure recovery in down stream of valve orifice can easily produce sound, which may propagate underwater, hence special consideration have to be made in certain valves.

INNOVATIVE VALVE DESIGN

14. Navy's fighting capability remains heavily dependent on both the developmental and exploitation of world class technology as well as innovation, be it in weapons and sensors ort the various equipment that go into building a potent fighting platform. Even though valves appear to be a simple element onboard the ship, there is ample scope for innovation, if one wishes to succeed in achieving our aim of becoming self reliant in valves technology.

15. In an ever growing business environment of today, Indian valve industry can ill afford to be run of the mill. The competition keeps on increasing and the most sensible way of sustaining is to innovate. Innovation should therefore be the dogma, on which Indian valve industry should succeed, so that we need not import in future. Fundamental issue therefore is to motivate the Indian valve industry to invest in R&D developing the technology needed for new and legacy valves and also improving the industry efficiency and competitiveness. These technological improvements should

include management practices as well as traditional R&D developments. Management must believe that investment in R&D will return profits and increase shareholder value.

16. The R & D efforts of the industry could be focused into four sections which are enumerated below.

(a) **Basic Research.** Systematic study directed towards greater knowledge and observable facts without specific applications toward process or products.

(b) **Applied Research**. Defined as gaining knowledge or understanding in order to determine the means to achieve a specific goal, such as production of useful materials or better systems and methods.

(c) **Product Development.** It is termed as the design or testing of prototypes for feasibility and risk reduction.

(d) **Systems/Process Studies.** It is defined as studying to improve or optimise economic operations through systematic review.

17. Unlike some other sectors of the industry, such as automobiles and aerospace, where R&D is relatively much higher, a cursory glance at Indian valve industry would be enough to highlight the non existence of the R&D infrastructure, except for a few. The non-existence of R&D in valve industry personnel, impact their ability to interface with supporting organization and academia. It is well known that it is the science that drives the technology and technology that provides new capabilities and therefore the innovation has to be in basic science, technology, process and the product development.

18. The advanced navies of the world have had the benefit of large scale investments in R&D and innovative thinking in the industries and academia respectively. Some of the examples are described in the succeeding paragraphs.

19. **Marine Composite Valves.** Faced with exorbitant cost of maintaining valves due to erosion and corrosion, the US navy way back in 1980's embarked on a mission to find alternative to their existing inventory of valves [6]. Besides the high end material that is Titanium, their search took them to use of composite technology that offered them the potential for significant cost savings in maintenance due to corrosion/ erosion resistance. The US navy has since developed a family of non metallic composite valves for shipboard applications from NPS 0.5 to 12, by taking it

7th Biennial Valve World Conference & Expo

Düsseldorf, Germany
30 Nov - 02 Dec 2010

The Valve World Expo presents continual growth, outstanding innovations and the highest level of technology at the new Düsseldorf location as of 2010. Valves and the entire palette of accessories, as well as the preceding and succeeding technologies take centre stage. The Valve World Conference, as the most important event of the industry, analyses the future of the markets against the background of fascinating developments and scientific evaluations.

Düsseldorf turns it on!

www.valveworldexpo.com

Sponsored by: BERNARD, KITZ, rotork, MRC, tyco Flow Control, YELAN

Supported by: API

Now get all the congress and trade fair information daily on your mobile! Simply use the QR Code Reader of your camera phone.

Messe Duesseldorf India Pvt. Ltd.
Centre Point 7th. Floor
Junction of S.V. Road &
Juhu Tara Road
Santacruz West
Mumbai 400 054
Tel: (022) 6678 99 33
Fax: (022) 6678 99 11
e-mail: info@md-india.com
Internet: www.md-india.com

Messe Düsseldorf

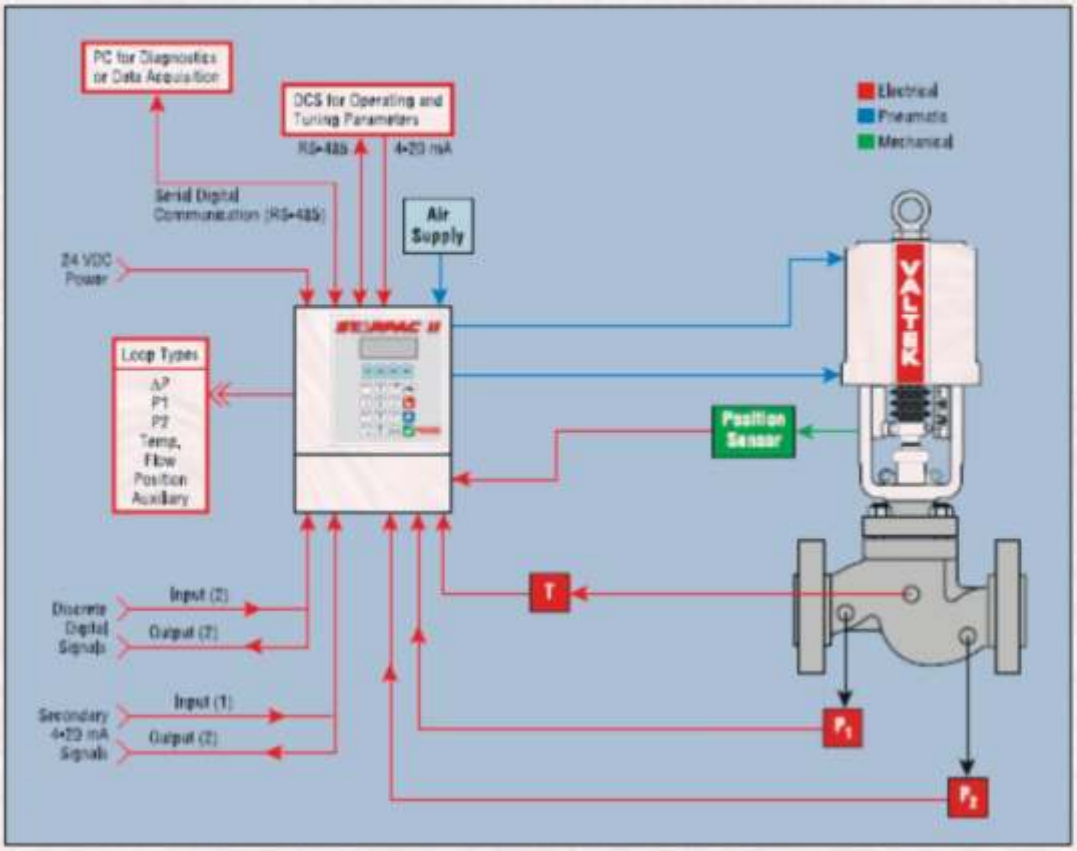


Fig 3 Smart Valve [10]

through a complete exhaustive and stringent qualification process by subjecting it to shock, low cycle fatigue, valve cycle actuation, vibration, pure tension, compression, bending and torsion, besides the routine hydrostatic pressure tests. The fire tests showed composite valves compared favourably to the other metallic navy valves in terms of leakage, besides being non toxic and flame retardant. One of the firm that has developed these valves is M/s Marotta Controls based in New Jersey [7] The other advantages offered by the composite valves are enumerated below.

Fig 4 Standard Solenoid Valve and MEMS Micro valve

(a) They are one third to one half the weight of valves made using traditional materials.

(b) They can handle dirty service (sewage) with minimal clogging.

(c) They are compatible with all pipe flange materials – no galvanic corrosion.

(d) Has quick manual and automatic operation (quarter-turn versus multi turn operation of gate and globe valve).

(e) Life cycle costs are likely to be 15% to 20% less than those associated with valves made from traditional materials.

20. **Smart Valves.** The

advanced navies found that with the decrease in manning levels, it is becoming increasingly difficult to manage the operation of valves in fluid systems, to ensure that the operational capability of the end user is not affected especially in time of damage. Many of the fluid system are particularly vulnerable to external damage due to their inherent distributed locations. The key factor being the time taken to reconfigure the system post damage. It was because of this shortcoming many navies began to investigate the possibility of smart valve technology to enable them to automatically reconfigure the fluid system. The Royal Navy commenced their Intelligent Fluid System programme in early 2003 [8].

21. A typical smart valve, shown in Figure 3, has four main components – valve body, actuator, controller and up/ down stream pressure transducer. Detailed studies on the concept demonstration test rigs, combined with modeling and simulation, has helped Royal Navy in evolving active reconfiguration of fluid system to support specific requirements. They found that smart control elements such as intelligent systems mounted on valves or digital positioners used with actuators have fewer or no moving parts, which leads to efficient operation and less prone to failures. Moreover, today's smart final control elements offer a whole host of new functionalities once thought futuristic, such as automatic loop tuning, self diagnostics, information processing, planned maintenance and warning/ alarm management are a reality [9].

22. It is in this field that the Indian industry has to be innovative in developing the various sensors for temperature, pressure and flow to enable production of the smart valves in the country.

23. **Micro Electro Mechanical Systems(MEMS).** One of the major technology that is beginning to show promise in valves application is the MEMS, that merges the nano scale into nano electro mechanical systems (NEMS) and nano technology. MEMS is an approach that uses the materials and processes of micro-electronic fabrication. It facilitates and conveys the advantages of miniaturization, multiple component integration, and microelectronics to the design and construction of electromechanical systems. M/s Microstaq is one the first company to develop the technology and commercialize it for macro-flow control applications. The time has now come to design electronic circuits with microprocessors, integrated circuits, resistors, capacitors and micro-valve flow control devices all on the same circuit board [11]. The differences between a standard solenoid valve and the MEMS micro valve are vast and are measured in orders of magnitude. The most significant difference is the size and weight of the micro valve, which is obvious just by visually comparing the valves as shown in Figure 4 below. The technology has tremendous potential in refrigeration/ air conditioning; hydraulic braking applications and may sometime in future replace a solenoid valve, wherein a micro valve can be used to pilot a large flow devices. Since the valve is made entirely of silicon, there is no longer concern over susceptibility of seals and metals to fluids. The valves can operate with any fluid that is non-corrosive to silicon and at temperatures that challenge the materials used to interface the micro valve to the system. The fundamental operating mechanism of the direct acting micro valve is a flow of electrical current through silicon 'ribs' which in essence are multiple resistive elements. These silicon ribs expand due to the resultant thermal expansion of the silicon and translate into a linear displacement of the valve mechanism.

24. The technology has tremendous potential and is waiting to be developed for the benefit if the mankind. It is time innovative uses for the MEMS technology is found by the Indian industry in indigenous valve manufacturing.

VALVE DESIGN INSTITUTE

25. With the accelerating technological change, innovation is no longer restrained to vertical structure of R & D laboratories and universities and is much more than generating new ideas. The authors therefore opine that with the Government, academia and industry partnership, there is an urgent need for a dedicated Valve Design Institute, to provide a total solution for valves catering to the diverse needs of the industry, in a focused manner. This

Institute would help in translating ideas into value-added products with a market value, with the aim to leverage the strength of academia and the industry, wherein the basic research from the academia would be aligned and attuned towards both short as well as long term industrial application. The time required for innovation to reach the market is a good indication of this. It is hoped that this Institute would attract the brightest minds to research by providing incentives and professional opportunities.

26. This Institute can focus on market driven research, encouraging commercialization of research and extending a knowledge base to industry to have a winning formula for all. The Vision, Mission and Role of this Institute can be collectively drawn up, to cater for research in basic sciences, technologies, processes and product; developing the necessary human resources skills in valves designing manufacturing operating and maintenance; providing the necessary test facilities as per different international and national Standards & Specification etc.

27. **Funding.** Industrial R&D schemes are being promoted by Government and the valve industry should therefore come forward, perhaps through CII, to gainfully utilize this excellent opportunity.

28. The funding of various programs would be available through different sources such as Government, DRDO, Navy, Industry and Venture Capitalist. Special budget head created by the Ministry of Defence and the Indian Navy; basic research funding by Naval Research Board of DRDO[12] are some of the avenues readily available for application in the Navy and Defence sector. Similar funding opportunities would be available through private industry also.

29. **Venture Capital.** The experience in some of the advanced countries such as US, Taiwan and Israel show that technological innovation and the growth of venture capital markets are closely interrelated. The pool of technical talent and the presence of entrepreneurial ethos are seen as a Indian principal comparative advantage [13]. Yet this has not resulted in large enough deal flow of new technology venture ideas. Venture investing thrives when technologically savvy serial entrepreneurs come to the market with some bright idea, implement it, make money, sell out and start all over again with a new idea. This culture of continuous entrepreneurship has to be developed with public support. The role of public support in the case of talented individuals and SMEs is to create facilities for supplementing their technical capacity with entrepreneurship education, advisory services for preparing business plans and a better connection with research institutions and laboratories that can help them to prove their ideas

30. The various areas of innovation/ research which can be used for naval application are enumerated below.

(a) Valve materials.

(b) Valve sealing rtechnology.

(c) Noise attenuation.

(d) Compact actuators.

(e) Limit switches.

(f) Sensors – pressure, temperature, position, flow.

(g) Intelligent valves.

(h) High precision control valves.

CONCLUSION

31. To increase the proportion of high technology based valves in global trade, R & D and innovation must be driving force to support competitive manufacturing. India is well poised to develop technology given its human resource endowments and to convert knowledge into wealth. As industry of all levels face the global competition, the current R&D initiatives need to be revisited to enable managements to invest in R&D in valves sector. There is therefore a need of a holistic approach towards managing business and promoting innovation to ensure overall industrial growth. The immediate benefits which would accrue as a result of innovation in the field of valves are listed below.

(a) Reduced life cycle costs of valves thereby reducing overall cost.

(b) Reduced manning of the systems.

(c) Nil dependence on foreign sources.

(d) Increased performance and better reliability of the valves.

(e) Development of Indian industry.

(f) Chance to compete in the world market.

(g) Recognition of the nation as a force in the field of valves.

(h) Opportunity for Indian youth to perform and satisfy their intellectual abilities and preventing 'Brain Drain'.

32. In conclusion, the authors opine that to the Indian industry have to meet challenges of modern warships that are increasingly adopting digital technologies, encompassing Gigabit Ethernet communication, integrated platform management system, voice over internet protocols, intelligent fluid systems etc. With the pressure to reduce manning on board warships, innovative solutions have to be found to increase the reliability , redundancy and life of simplest yet very important element i.e. valves of the ship wide fluid systems. Setting up of the Valve Design Institute, indeed would be step in the right direction.

REFERENCES

[1]"Revitalisation of Indian Shipbuilding Industry – A Strategic Imperative", published by Integrated Headquarters, Ministry of Defence (Navy), 2006.

[2] Background Literature of Global Industrial R & D conclave organized by Dept of Science & Technology, Government of India, Confederation of Indian Industry and Global Innovation and Technology Alliance 11-12 May 2009, New Delhi.

[3] RK Rana, "Indigenisation of Valves – An Opportunity for Indian Industry" CII Valves Conference Dec 2008.

[4] "Rationalization of Valves Project 71" IHQMOD(Navy)/DND document no. ESSG/SR/2008/01 dated July 2008.

[5] M/s NFTDC drawing no. 9090C/P06/07-06/521-01-207.

[6] V Bhasin, D Conroy and J Reid, "Development of Family of Commercial Marine Composite Ball Valves" Naval Engineers Journal July 1998 page 51.

[7] www.marotta.com

[8] LtCdr MA Goodall and Dr G Doherty, "Intelligent Fluid Systems" Journal of Naval Engineering" Aug 2006 page 41-58

[9] Valve Handbook by Philip L Skousen.

[10] www.flowserve.com

[11] Mark Lukevich, "MEMS Microvalves the New World" Valve World May 2007 page 79-83.

[12] www.drdo.org

[13] Venture Capital and Innovation: The Indian Experience: Dr. B. Bowonder, Director, Tata Management Institute & Dr. Sunil Mani Researcher at the United Nations University, Institute for New Technologies, The Netherlands.

BIO DATA

Commodore (Dr) Rakesh Kumar Rana was commissioned in Indian Navy on 01 Aug 1979. He completed his post graduation from Royal Naval Engineering College, UK. He was awarded with PhD degree by IIT, Madras in Jul 96. Commodore Rana has served in a variety of organizations in the Navy encompassing training, research, dockyard, staff, ship design and onboard ships. He was awarded Commendations by Director and Dean twice at IAT Pune in 1986/87 and by CNS in 1992 for his pioneering contribution in the field of marine engineering training, research and development respectively. The officer has more than 30 technical publications on various marine engineering subjects to his credit and is a Fellow of The Institute of Marine Engineering, Science and Technology, UK; Member of The American Society of Naval Engineers, USA; and has been granted a status of Chartered Engineer by The Engineering Council, UK. He is presently serving as Principal Director at Integrated Headquarters, Ministry of Defence (Navy), New Delhi, with the responsibility of indigenous development of equipment and systems. **Commander Neeraj Chawla** is presently serving as Joint Director in Directorate of Indigenisation at Integrated Headquarters, Ministry of Defence (Navy), New Delhi. The officer has served on ships Deepak, Bedi and was commissioning Engineer Officer of Darshak. Cdr Chawla has held instructional appointment at Shivaji, has also served in Headquarters Eastern Naval Command, Visakhapatnam and was Joint Director at Directorate of Naval Design Integrated Headquarters, Ministry of Defence (Navy), New Delhi. The officer is member of Institute of Marine Engineers (India) and has been commended by CISC in 2005.

(Courtesy : Valves' Divn. CII, This paper was presented at Annual Valves' Conference of Confederation of Indian Industry in December 2009 in Mumbai)