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**CONNECTORS/CABLES/WINCHES;
OFFSHORE RENEWABLES/OFFSHORE TECHNOLOGY**



Optimised

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SEACON underwater electrical connectors fulfill customer requirements when one size does not fit all

Over the last several decades, underwater electrical connector technology has been driven by, and kept pace with, customer requirements. History shows that technical parameters such as mate/de-mate requirements, operational depth and material selection vary by application, but often are constrained by budget. Prioritisation of the technical “wish list” with the budget in mind is often required when deciding which standard or customised connector will meet all absolute technical requirements and as many of the softer requirements on the wish list as possible.

By working with customers to distinguish between required connector performance characteristics and “nice to have” capabilities, the SEACON Group, a globally based family of companies with a global customer base, has established an enviable track record of optimising underwater connectors for wide-ranging, predominantly subsea, applications. The SEACON Group was profiled in the May/June 2010 issue of *International Ocean Systems* magazine.

SEACON has worked closely with a disparate universe of customers to develop, test, customise and refine an array of products now in widespread use in the underwater work environment

spanning ocean science and engineering, defence, seismic and offshore oil and gas applications. Although the company’s various divisions also manufacture optical and electro-optical hybrid, wet-mate and dry-mate connector systems, this article focuses primarily on SEACON’s electrical wet-mate and dry-mate connectors. Table 1 shows SEACON products included in these categories, as well as associated connector mating methods/environment

and operational depth. It also relates working applications (eg, BOP, control systems, seismic arrays, etc.) to customer connector choices.

TECHNOLOGY BACKGROUND

Since its founding in the mid-1960s as a small San Diego, California, connector manufacturer, SEACON has been at the forefront of connector technology development. Within a few years, having

Product Category	SEACON Connectors	Applications	Mating Method/Environment	Operational Depth (metres)
Underwater Mateable	CM2000.	Control Systems; BOP; Floating Production Storage & Offloading (FPSO) Vessels.	ROV/Stab; Plate/Diver/Shipboard/Sea surface, Dry protected environment.	7000 (pressure-balanced)
Wet Pluggable (Metal Shell)	SEA-MATE.	Defence (submarines); International Seismic; Oceanographic Monitoring; Dredging.	ROV (some trials to test for use with ROVs); Diver/Shipboard/Sea surface or Dry, protected environment.	6000
Wet Pluggable (Rubber)	WET-CON; ALL-WET; Micro WET-CON; GLOBE-CON (Wet-mate version).	ROV; Instrumentation; Lights/Cameras; Control Pods (internal).	Diver/Shipboard/Sea surface or Dry, protected environment.	13,000
Moist Mate	Special versions of these connectors, to meet high-voltage requirements in high humidity: Metal Shell Series; MINI-CON; Moist Mate.	Seismic Arrays; Land-Based Seismic; O&G Distribution Systems.	Shipboard/Sea surface or Dry, protected environment to 10,000 metres.	13,000 (pressure-balanced available)
Dry Mate	MINI-CON; Metal Shell Series; 55 Series; Hummer; GLOBE-CON; Rubber-Moulded; GRE; CS-MS; Micro MINI-CON; 66 Series.	Control Systems; BOP; FPSO; ROV; Instrumentation; Lights/Cameras; Control Pods (internal).	Dry, protected environment.	13,000 (pressure-balanced available)

Table 1. SEACON Underwater Electrical Connector Matrix

connection

established a healthy dialogue with both the university oceanographic research and US Department of Defense communities, the company was producing connectors for classified military operations. The following are some major underwater electrical technology milestones of the last 40-plus years in which SEACON has played a leadership role:

1. Development of high-density electrical contacts within compact dry-mate electrical connectors. The higher density of contacts and smaller compact design enabled more communication channels to be used within a single connection.

2. Development of underwater mateable connectors with modular contact assemblies and alternative sealing technology, conforming to industry standards. While other manufacturers' underwater mateable connectors adopted a common sealing principle, SEACON implements an alternative sealing principle. This provided many technical advantages, including dual-barrier sealing on all contacts, very low connection mate force, ability to provide numerous channels within a shell and even multiple channel sizes within the same shell.

3. Split connector templates, enabling multiple connector plugs to be mated to a single connector. Typical applications for such assemblies include ROVs, AUVs and subsea control pods. The single penetration helps in the design considerations of the normally one-atmosphere electronic chambers, while

Division	Location	Specialisation	Contributions to U/W Electrical Connector Technology Development
SEACON	El Cajon, CA, USA	Dry-mate electrical connectors and cabling systems	New standard and special connectors, including high-strength terminations
SEACON Advanced Products	Bellville, TX, USA	Underwater mateable electrical connector systems, downhole wet-mate and dry-mate electrical connectors	Standardisation of field-installable connector solutions
SEACON (europe)	Great Yarmouth, UK	Electrical connectors and cabling systems; harsh-environment wet-mateable connectors and assemblies	Developed metal shell and wet pluggable metal shell connectors capable of being handled by ROVs
SEACON Global Production	Tijuana and Xalapa, Mexico	Electrical harsh-environment underwater mateable connectors and assemblies; electrical dry-mate connectors and assemblies	Reduced-temperature rubber moulding to enable use of lower temperature-tolerant cables
SEACON Precision Subsea	Nottoden, Norway	Electrical distribution systems with wet-mate and dry-mate connectors	Pressure-balanced, oil-filled conduit
SEACON Phoenix	Ashaway, RI, USA	Glass-sealed electrical connectors and feed-thrus; MIL-SPEC approved connectors	MIL-SPEC electrical connectors and harnesses, high-density glass-sealed underwater electrical connector inserts

Table 2. SEACON Division Specialties and Connector Technology Development

still providing the flexibility of individual cables running from the bulkhead to multiple instruments.

SEACON DIVISIONS

The SEACON divisions shown in table 2 all contribute to overall corporate capabilities, while specialising in connector types targeted at requirements for the market sectors they serve. The table also shows each division's technology contributions.

DEEP-OCEAN WORK CAPABILITIES

Deep-ocean science and engineering possibilities enabled over the last 40 years

by advances in underwater electrical connector technology include the following:

1. Development of subsea infrastructures that have required modular deployment and subsea interconnections. As the infrastructures being deployed subsea become ever more complex, the interconnection needs multiply as a result of both quantity and the need for maintainability.

2. Connectors have enabled simple, rapid component replacement. This is a key capacity that enables manufacturers to conduct modular testing during manufacturing and controlled fault investigation and repair to equipment,



Figure 1.
CM2000 3.3 kVAC
underwater mateable connector

minimising both resource time and equipment downtime.

3. Field-installable and testable solutions for installation offshore have enabled much more reliable systems to be operated and repaired offshore.

In some of the harshest environments, SEACON technology has enabled drillships to drill deeper and continue operating for longer periods. When problems do occur, rapid re-termination is essential, but quality of repair and ability to test and validate seals and communication prior to redeployment are also essential.

CUSTOMER TRADE-OFFS

End-users naturally seek the highest levels of connector performance for the most economical price. Market realities may

dictate compromise in order to meet operating requirements with the capabilities of off-the-shelf underwater electrical connectors. Examples of such a compromise are:

A customer wanted to adapt and mould an off-the-shelf bulkhead connector to a special customer-designed and supplied Kevlar cable. SEACON modified the original connector shell design, to be able to terminate the Kevlar properly in a very limited space. After considering the trade-off, the customer accepted a slightly larger connector body to gain sufficient space for the cable termination.

Another customer wanted a low-cost, low-profile, wet-mateable connector, with an integral penetrator. SEACON met these requirements with its Low Profile WET-CON connector solution and incorporated a penetrator seal into the body of the bulkhead that lay inside the customer's equipment. Although overall cost increased due to the higher level of technology in the connector, it eliminated the even higher cost of replacing damaged

electronic equipment.

Yet another SEACON customer wanted a CM2000 connector, but did not have sufficient budget. After more detailed review of technical requirements, it was established that the less expensive SEA-MATE connector met the customer's specification.

Figure 1 shows the CM2000, and figure 2 shows the SEA-MATE wet-mateable connector – two of the hundreds of connectors in SEACON's overall product line.



Figure 2. SEA-MATE wet-mateable connector

THE FUTURE

The last four decades have witnessed underwater connector technology advances that were practically inconceivable before that period. Technology challenges still exist and with them the need for continued development work that likely will involve vendor/end-user partnerships. Such partnerships, with industry responding to the operator-level feedback regarding needed connector capabilities, have spawned the technology leaps that have brought connector performance characteristics to their current level. SEACON has been involved in many such partnerships and continues to take a leading position in developing solutions to meet the challenges of deploying underwater electrical connectors.

As applications emerge for reliable connector performance in deeper, harsher environments, there will be a continuing need for an industry/user dialogue to apply both current and emerging technology to increasingly complex customer requirements for work in the deep-ocean. SEACON will continue its long tradition of providing optimum underwater-mateable electrical connectors to end-users in all market sectors, from oceanographic research to defence-related and offshore oil and gas applications.

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