/DAVD: Diver Augmented Vision Display
GEN 3.0

Revolutionary diver vision and operations solution

Benefits

- Revolutionize Diving with enhanced vision and operational awareness even in zero visibility conditions
- Hands-Free Dive Operations addition to standard unmodified Defense and Commercial dive helmets and Full-Face Masks
- Fully integrated innovative ultra-low light, first person camera with video processing and edge enhancement
- Synchronized Diver and Supervisor Real-Time display for coherent dive control and enhanced safety
- Telemetry HUD data displayed on demand including Dive Timers, Depth and Compass Heading and Live position and bearing
- Instant Digital Voice and Text Communication between Dive Supervisor and Diver, including auto and pre-defined messaging
- Unlimited access to media data for Diver including Images, Instructional Videos, Technical Drawings and other assets to assist in live operations

DAVD System Overview

The Diver Augmented Vision Display (DAVD) is a complete end-to-end diver management solution incorporating a high-resolution see-through head-up display (HUD) embedded directly inside the diving helmet. This concept of using a pair of transparent glasses underwater is protected by patent.

The HUD is controlled from the surface by the Dive Supervisor using the supplied 4G Underwater Survey Explorer – "DAVD Edition" software suite and they are able control all information displayed to the diver including the ability to show real-time 3D imagery of the diver's environment in 1st or 3rd person perspective, regardless of the water visibility conditions.

In addition to the provision of Mixed Reality (MR) scene awareness, the dive supervisor can communicate seamlessly via real-time images, videos, technical drawing, text style messaging and step-by-step instructional sets. Effectively, the diver has full on-demand access to all the technical data, know-how and support from the team on the surface to affect the best outcome of the mission. The integration of the diver head tracker and low-light HD Camera further allow complete understanding of the Divers motion, head orientation and immediate real-time working scene. Replacement of the diver legacy communication with all new digital audio allows amongst other benefits, auto-noise cancellation and background noise suppression providing clear speech audio and voice command assistance between diver and dive supervisor.

The DAVD system can be used either in "rapid" deployment scenarios where minimal prior information is known or scanned, or in "Simulation and Planning" scenarios where a detailed prior 3D map of the scene is created and then annotated by the Diver and Supervisor. The latter scenario affords the greatest functionality and is particularly beneficial for repeat dives on a work site, such as a salvage operation, where data, information and spatial context can be built in real-time and incorporated into the mission for subsequent dives.

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Through the use of the **4G USE®** *DAVD Edition* software package and the supporting equipment, the diver can then receive a range of real-time display information including:

VISUALIZE:

- Real-Time 1st Person Ultra-Low Light Edge Enhanced Video Feed for Diver and Supervisor
- Complete 3D Spatial Environment with Live or Pre-Survey Sonar data, 3D Models and Geo-Referenced Technical Data
- 3D Waypoints, Hazards and Navigational Paths with live range and bearing
- Unlimited Images, Videos and Billboards within the 3D view
- Simulated dive of 3D environment before the diver enters the water

COMMUNICATE:

- Text, Voice and Video messaging with the Dive Supervisor team Navigation and Direction instruction and symbology
- Dive Timers, Geo-Triggers with Alerts and range and bearing to selected waypoint targets or hazards
- Dive Telemetry data including Compass Heading, Depth, Position, Target Bearing, Elapsed Time and Decompression Profiles

ASSIST:

- Live 3D measurements of assets and targets of interest with Geo-Tagging information around Hazards or key Targets
- Complete Dive Supervisor Interaction with visual content seen by Diver Workflow management – comprehensive step-by-step task instruction management
- Augmentation of the 3D scene with hazards, 3D Models and technical data
- Live Diver Camera enhancement with real-time drawing tools

LOCATION
Provide the Location of the Diver, the Diver Stage and Work Site and any hazards

VISIBILITY
Enhance the Diver experience with real-time Augmented and Mixed Reality scene awareness

COMMUNICATION
Communicate with rapid TEXT messaging for instruction, guidance and acknowledgement

SAFETY
Diver and Supervisor visually synchronized and can coordinate movement, tasks and health status

DATA
Diver and Supervisor can share and access all project technical and visual data in real-time

MANAGE:

- Provide any Technical Data to the diver in real-time and on-demand “How to” On Demand Instruction and Reference Material
- Collect, present, and annotate the live scene or any Images, Photos and Media
- Record all or part of the Dive for later review or as a training aid for team members or subsequent missions.

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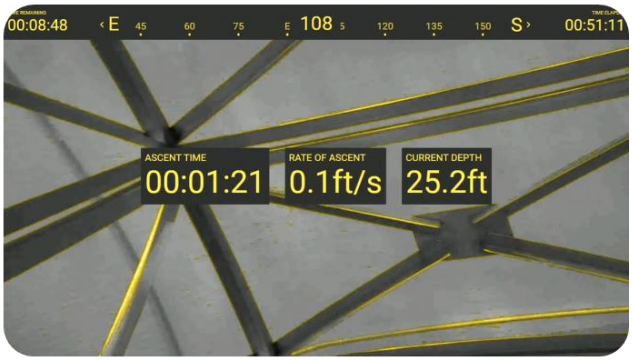
DAVD System Operating Modes

The DAVD System can be used in many different configurations to suit the operational requirements. The two primary modes of operation are discussed and illustrated below.

DAVD 2D-Mode
DAVD Gen 3.0

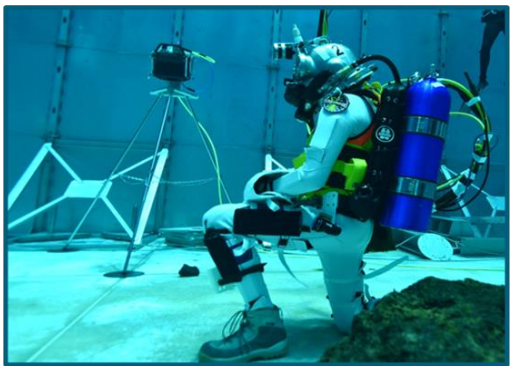
No Additional Sensors Required

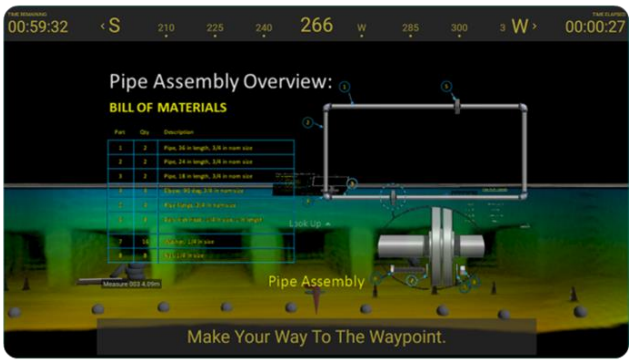


DAVD 2D-Mode allows a very quick setup and deployment with no additional sensors or setup required. Focussed on use of the Ultra-Low Light enhanced edge video, the supervisor can provide all of the available telemetry and timer information for the diver. Additionally, the supervisor can provide display of videos, images, technical drawings and messages in real-time to assist the diver throughout the mission. Custom Mission Overlays can be setup in advance or in real-time to provide workflow instructions and quality control steps for set processes and procedures. Setting the Dive Time in advance enables the diver to monitor the time in water and mission time remaining to ensure that they don't exhaust the mission time which was set prior to them entering the water.

DAVD 3D-Mode
DAVD Gen 3.0

C500 Inspector System
Pre-Scan 3D Data & Models
Subsea Positioning System
3D MATT





DAVD 3D-Mode has all the great features of the standard 2D-Mode but offers a completely immersive 3D environment. Typically, the DAVD system is paired with the C500 Inspector System, or a standard Echoscope® survey and inspection system. The Echoscope® real-time volumetric imaging sonar is used to capture the 3D scene data for the mission environment either before or during the dive and allows the diver and supervisor to pre-plan dive routes and objectives and highlight critical asset locations as well as hazards.

The supervisor can send the complete 3D environment data to the diver as shown above, providing a complete Mixed Reality environment combining the sonar imaging data and the live enhanced camera image. This provides a significant aid to divers, particularly in poor visibility conditions. It further allows virtual instructions, Images and 3D Models to be placed within the 3D environment so that the diver can see and interact with these items spatially.

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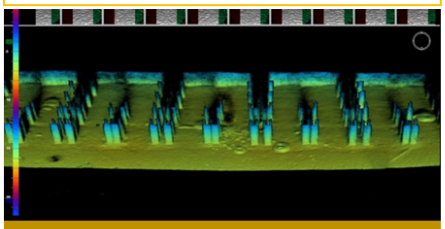
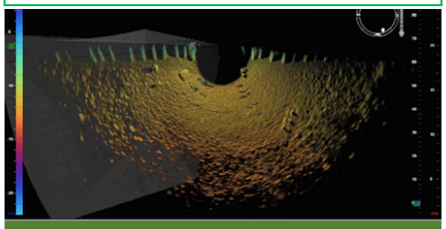
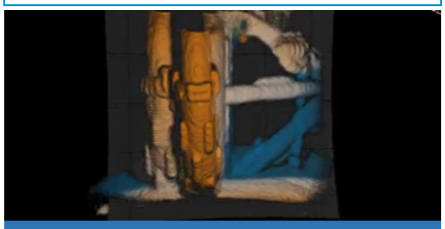
DAVD 3D-Mode Typical Workflow

3D Area Scan

The initial step prior to the diver entering the environment is to create a baseline 3D Map. Depending on the deployment, the 3D map can be created in advance or immediately prior to the diver entering the water. Using the C500 Inspector System or a standard Echoscope® survey system, scanning the area in which you will be undergoing the mission is critical to providing clear direction and control for the diver to safely navigate the mission area.

There are three types of 3D area data collection - detailed survey, fixed scan and real-time hand-held inspection.

C500 Survey/UIS Mode Survey in advance of dive operations	C500 Inspector Mode Scan from a fixed location	C500 Hand Held Live Scan of area in real-time
• **Highest Resolution 3D scan** with minimal shadows and optimum target illumination • **Completely Georeferenced** dataset allowing instant augmentation with other spatial data. • **Cover larger survey areas** such as construction site or salvage operations	• **Simple setup** on barge, quay wall, tripod or fixed structure. • Create full 3D scan in **10 seconds** • Data collected from a single viewpoint so **some targets will remain in shadow** • 3D Scan configuration can be used to show **Live Diver tracking**	• **Simple setup** with Diver benefiting from real-time Forward looking 3D Data – 1st Person Perspective • **Real-time 3D image display only** with no mapping capability. • **Diver can swim with sonar** to work location and then stand system nearby
		
3D Data Quality: **Highest** Setup Complexity: **Moderate** Survey Mapping: **YES** Real-time Monitoring: **YES**	3D Data Quality: **Good** Setup Complexity: **Simple** Survey Mapping: **Fixed Scan** Real-time Monitoring: **YES**	3D Data Quality: **Standard** Setup Complexity: **Simple** Survey Mapping: **NO** Real-time Monitoring: **YES**

DAVD Diver Simulator

The built-in Diver Simulator allows the diver and supervisor to use the 3D area scan data to virtually swim the mission areas and pre-plan routes, mark hazards and plan the effective execution of the dive tasks in the mission. Divers can also use the simulator function to feel comfortable with the data and environment prior to entering the water.

Additionally, as each dive can be fully recorded as a virtual “black box”, the DAVD Dive Simulator can provide comprehensive replay of the recorded mission as a further training aid or to continually monitor and enhance Safety, Efficiency and the Effectiveness of the precious bottom time for each diver in the mission.

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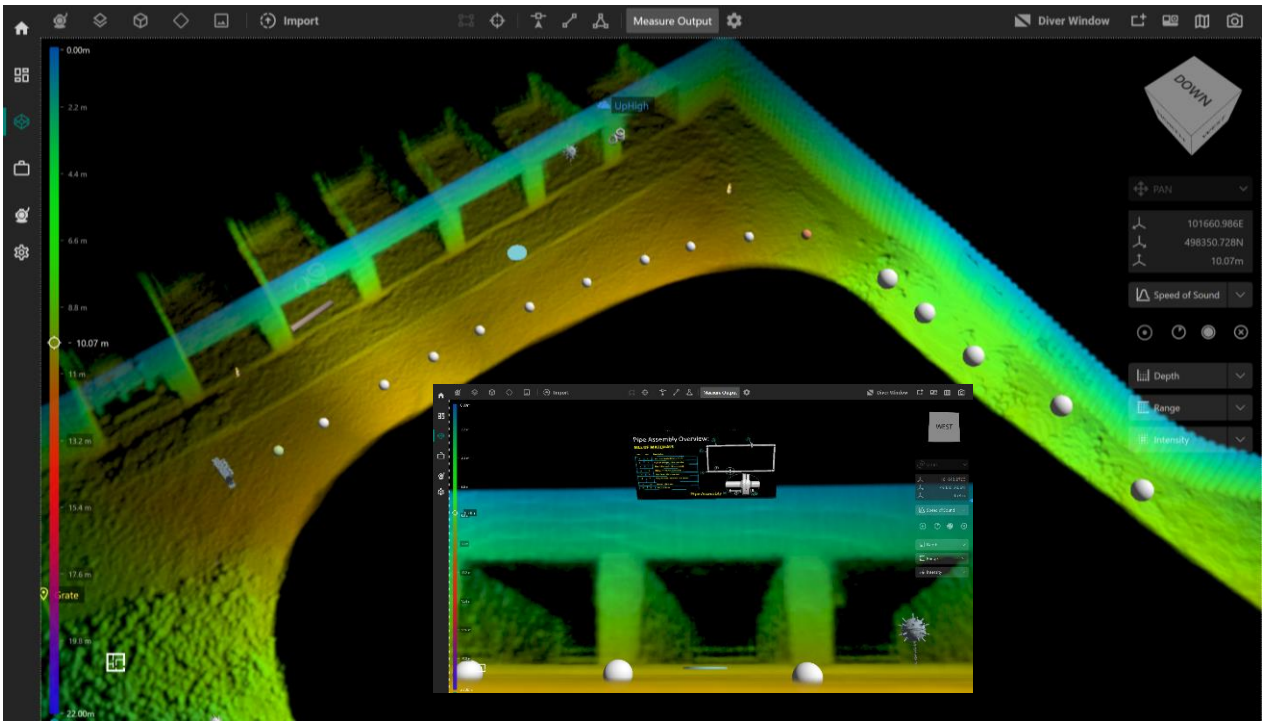
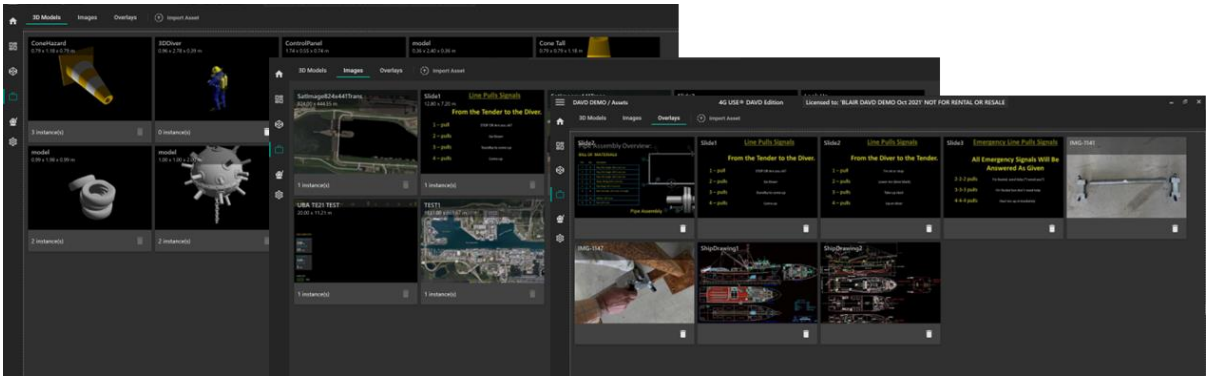
Scene Augmentation

3D scene can be easily augmented with 3D models, billboard instructions and markers with measurements of known structures, targets and geo hazards. This makes the 3D Scene for the diver richer and contains relevant and vital information and data spatially aligned with the physical assets they are near or may be looking at. A significant safety aspect forte DAVD is the ability to annotate the 3D scene with the diver ahead of them entering the water, this makes it significantly less likely for hazards to go unseen and lowers the risk of the dive operation. As shown below, models are used to mark areas or objects of interest and also to lay out diver route paths that make it as easy as GPS navigation for the diver in the challenging subsea environment.



Media Library

The project can be preloaded with Mission Overlays which provide controlled step-by-step instructions for a diver to follow complex or critical processes or procedures, technical drawings, asset images and instructional videos to help assist the diver throughout the mission. The Media assets can be placed within the 3D environment (as shown above) or can be accessed on demand and displayed in full screen or as an inset to the diver at any time the need the information or data.



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DAVD Features

- Fully Transparent High-Definition Head-Up Display
- DAVD HUD supported in Kirby Morgan KM37, KM37SS, KM97 and SL17/27 Helmets, as well as the Interspiro Divator MK II, OTS Guardian and Dräger Panorama Nova Dive Full-Face Masks
- Fully integrated 1st person perspective digital low-light camera with advanced video processing and real-time edge enhancement for Diver and Dive Supervisor
- Fully integrated noise-cancelling Digital Audio replacing legacy communications
- Integrated Diver Head Tracking for accurate 3D scene visualization with full support for subsea positioning systems for accurate Diver positioning
- Telemetry Information on demand including Dive Timers, Depth and Compass Heading, Live position Lat/Long (when connected to external diving positioning system), Waypoint Range and Bearing as well as Dive Computer data
- Instant Digital Voice and Text Communication between Dive Supervisor and Diver, including auto and pre-defined messaging
- Transmit unlimited on-demand media to Diver including Images, Instructional Videos, Technical Drawings and other assets to assist in live operations
- Creation and transfer of unlimited step-by-step mission instructions with text, video and image support for common diver tasks and operations
- Full Mixed-Reality 3D Display for Diver using live Sonar, pre-surveyed Sonar data and 3D models
- Divers HUD Display fully adjustable between 2D Mode, and 3D Mode with 1st person and 3rd person perspective
- Creation and transfer of unlimited step-by-step mission instructions with text, video and image support for common diver tasks and operations

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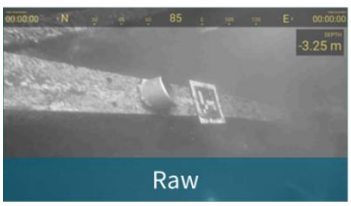
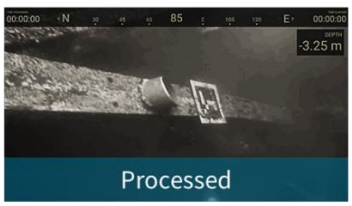
DAVD Feature Highlight

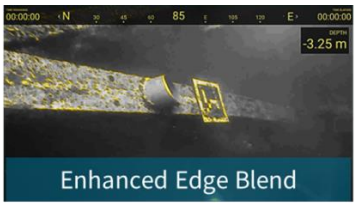
Real-Time Video Processing with Edge Enhancement

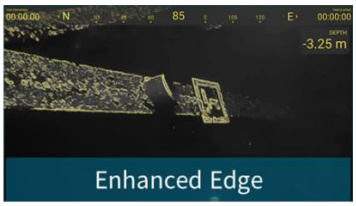
Divers have for a long time carried Video Cameras to allow the surface supervisor to monitor and assist with the diver operations. The diver however is never the beneficiary of the video data and too often the diver assumes the role of cameraman for the surface team without ever seeing through a viewfinder or screen what they are looking at.

Video underwater can be very challenging, especially in the dark and sediment filled waters that prevent the effective use of traditional illumination. The DAVD Camera incorporates an ultra-low light HD camera module with optional illuminators that is connected digitally to the DAVD DPP processor. The DAVD Gen 3.0 system reverses the traditional role of video underwater whereby the Diver receives the highest resolution lowest latency video directly to their HUD and this data is then broadcast to the dive supervisor and support staff.

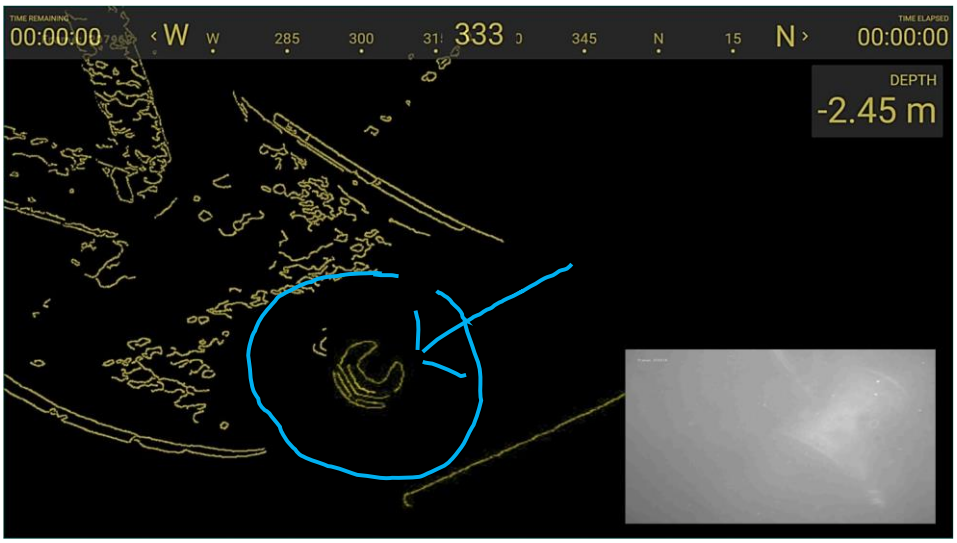








The dive supervisor can further enhance the video by hand annotating the scene to highlight an item or object of interest that the diver may not be able to see. The raw video image is shown (inset) for reference without any additional processing or enhancement.



Real-Time Digital Audio

Traditional diver audio communications can be challenging in the best of conditions and is the only and primary form of communication between the diver and the supervisor. DAVD Gen 3.0 opens the gateway to a new era of digital diver communications with the surface, providing a number of critical features including auto-noise cancellation and background noise suppression. These functions provide clear audio communications even with background noise at either the diver or on the surface. Recorded speech, videos with audio tracks ands automated computer speech instruction are output digitally from the DAVD DPP on the diver in crystal clear audio.

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DAVD Specifications

DAVD-CP (Central Processor) *yellow pelicase*	
Physical	
Dimensions (l x w x d)	524mm x 428mm x 206mm (20.62in x 16.87in x 8.12in)
Weight	9.94kg (21.8lbs)
Power Input	110-220V AC

DAVD-CAM (Ultra-Low Light Camera with Diver Motion Unit)	
Physical	
Dimensions (l x w x d)	63mm x 63mm x 74mm (2.48in x 2.48in 2.91in)
Weight	0.35kg (0.77lbs)

DAVD-DDP (Diver Data Processor)	
Physical	
Dimensions (l x w x d)	192mm x 87mm x 45mm (7.56in x 3.42in 1.77in)
Weight	1.27kg (2.8lbs)
Power Input	24V DC

DAVD-LAPTOP & PSU	
Physical	
Dimensions (h x w x d)	20mm x 360mm x 250mm (0.78in x 14.17in x 9.84in)
Weight	Combined 2.58kg (5.7lbs)

DAVD-REEL (300ft Umbilical on open frame reel)	
Physical	
Dimensions (h x w x d)	520mm x 340mm x 550mm (20.5in x 13.4in x 21.6in)
Weight	22kg (48.4lbs)

DAVD-HUD Assembly (HUD and CA0000504 cable assembly)	
Physical	
Dimensions (h x w x d) (Approximate)	115mm x 201mm x 77mm (4.53in x 7.91in x 3.03in)
Weight	1.0kg (2.2lbs)

DAVD Helmet and Face Mask Compatibility

The Head-Up Display (HUD) unit supplied is directly compatible with standard Kirby Morgan® KM 37*, KM 37SS, SL17/27* and KM 97 dive helmets** through the use of a modified KM Face Port onto which the HUD unit is mounted and a modified KM Communications Module. A Full-Face Mask HUD is also available with adapters for Interspiro Divator MK II, OTS Guardian and Dräger Panorama Nova Dive Full-Face Masks

The DAVD product permits the simple and quick conversion of any standard KM 37, KM37 SS, SL17/27* or KM 97 dive helmet to a DAVD-Ready HUD helmet.

**The KM37 and SL17/27 helmets, due to internal tolerances of the fiberglass shell require the new Navy approved compact Air Train Assembly to accommodate the HUD assembly.*
This is supplied as part of the DAVD product and is part of the class certified DAVD System. Ref: DL-545-016AB (Coda PN: HW0000766).
No modifications are required in either the KM 37 SS or KM 97 helmet and are directly compatible with the HUD assembly.

Helmets or Face Masks are not supplied with the DAVD System.

	Depth Rating (m/ft)	**Pressure Rating (bar)**
DAVD SYSTEM	100m / 328ft	10
HUD Glasses	100m / 328ft	10
DPP	100m / 328ft	10
CAM (including DMU)	100m / 328ft	10
Cable CA0000500	100m / 328ft	10
Cable CA0000504	100m / 328ft	10

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