



World leaders in diving equipment technology

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**Background:** The need to utilise diving equipment to help isolate the diver from a range of possible in-water contaminants has long been recognised. Drysuits with hoods have been used with full face masks with varying degrees of success for a number of years. Free-flow diving helmets attached directly to drysuits have been another alternative, and surface demand diving helmets (similarly mated to a drysuit) and fitted with double valved exhaust ports were also an option. However, these systems all have a basic flaw; they exhaust directly into the surrounding water. In doing this they expose an obvious route for water ingress, as each time an exhaust valve opens, water (or water droplets) frequently enter the helmet. Anyone questioning this simply has to survey the average full-face mask or helmet at the end of a dive to witness a significant amount of water that is not simply sweat and condensation. Very few helmet divers ever really experience a 'dry dive'. Most divers experience a level of leakage into the diving mask or helmet which is normally regarded as acceptable in clean water. The water dump valve at the bottom of standard masks is for just this occurrence. However standard exhaust valves, ill fitting neckdams and poor neck clamp arrangements all permit water leakage into the helmet or mask.

#### Important - Safety Notice

Divex do not accept responsibility or liability for incorrect use of this equipment. Diving in polluted/contaminated waters is extremely dangerous. It is essential that the contractor, user and diving team fully understand the type and level of contamination to be encountered in and around the dive site. It is essential that appropriately qualified professionals assess the suitability of the equipment to be used. The compatibility of the components and materials of the Dirty Harry System, and of course other equipment to be used, must be verified by appropriate persons.

## 'Dirty Harry' Contaminated Water Diving System

**Levels of Contamination:** At what point is water regarded as contaminated ? Although no definition exists of the levels of the majority of contaminants that cause health problems in diving, it is obvious that diving in certain areas requires protection e.g.

- Sewage plants and outfalls
- Chemical spills into waterways
- Nuclear cooling ponds
- Chemical drum recovery\*

**Respiratory Protection:** Respiratory inhalation is the most rapid route for any contaminant or substance to enter the blood stream. Water droplets and water vapour can form within the diving helmet from any leaked water. Operation of the demist valve and turbulence of the gas mixture from within the helmet through operation of the breathing valve all contribute to creation of droplets. Even more straight forward is ingestion of water through swallowing.

The primary contamination protection should be protection of the gas quality.



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**Skin Protection:** The second obvious method of contamination is into the bloodstream via the skin. Adequate protection from water contact to the skin is available by use of drysuits - obviously wetsuits are not suitable. However, there are a number of considerations even in the use of drysuits:

- 1 Suit material compatibility with the contaminant as certain chemicals will react with some suit materials.
- 2 Latex cuffs and neckseals may have similar compatibility problems to "1".
- 3 Suit inflation and in particular exhaust valves are regular sources of water leakage into the suit.
- 4 Hand protection should be considered with the use of chemical compatible dry gloves.

**Good Practice:** Divex strongly recommend the use of two divers as a minimum in accordance with good diving practice (Refer to ADC Guidelines). The dive control panel and vacuum exhaust panel are therefore configured for two divers. The rationale behind this is that the standby diver must also be dressed in the same equipment as the working diver, as he would have to enter the same environment in the event of an emergency.

### The 'Dirty Harry' System

**Introduction:** The 'Dirty Harry' Closed Circuit Diving System is designed to provide a safe and efficient surface supplied system which minimises the risk of contact between the diver and the water in which he is diving.

The basic method of achieving this is by providing a closed circuit breathing system whereby the divers exhausted gas is returned to the surface and exhausted to the atmosphere rather than exhausting into the water.

The helmet is attached directly to the drysuit. The proven Ultrajewel 601/17C Reclaim Helmet is used in conjunction with a Diver Panel, Exhaust Control Panel and the 'Dirty Harry' Drysuit which is available in various materials.



**Major Components & Function:** The Ultrajewel 601/17C Reclaim Helmet consists of the Divex Ultraflow 601 Demand Regulator and Ultrajewel 601 Exhaust Reclaim Regulator fitted to a Superlite 17C Helmet. The Ultrajewel 601 Helmet is suitable for diving depths up to 450msw (and conforms to the HSE/NPD Work of Breathing requirements) and is designed to provide fully closed circuit demand and exhaust functions which minimise the risk of water from the diving environment entering the diver's helmet.

The Ultrajewel 17C helmet has the patented Ultrajewel 601 exhaust regulator. This two stage valve provides added diver security.

The Divex Ultraflow balanced 2nd stage regulator overcomes pressure fluctuations in the supply system allowing the valve to provide adequate breathing gas under all conditions.

Typically, the pressure losses experienced in many dive panels and umbilicals often lead to a regulator not conforming with the HSE/NPD Guidelines for Breathing Resistance. The Ultraflow regulator performs within these guidelines and over a wide range of pressures at the helmet (between 5-20 Bar).

The helmet neck ring is bonded to the 'Dirty Harry' suit to prevent potential water ingress at the neckseal.

**Umbilical:** The 'Dirty Harry' Umbilical PP070 is constructed from the following components:

- 1/2" RH-08 Return Line / Reclaim Hose
- 3/8" DH-06 Air Supply Hose
- 1/4" DH-04 Pneumofathometer Hose
- 4 Core Communications Cable

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A benefit of the Ultraflow regulator's ability to accept supply pressures up to 20 Bar is that this enables a small (1/4") hose to be used, if required, rather than the normal 3/8", hence reducing the umbilical size. Whereas the system is normally run on conventional hoses, Divex offer (to special order) this specially designed small diameter umbilical for use by dive teams who have space and size limitations. With a diameter of only 32mm (1.25") and containing gas supply and return hoses, pneumo and comms, this umbilical is still smaller than many conventional open circuit systems.

**Suits:** Drysuits made in three different materials are available to help overcome material compatibility problems that may occur in some chemical situations. The suit materials are:

- 1 Polyurethane
- 2 Butyl Trilaminate
- 3 Natural Rubber

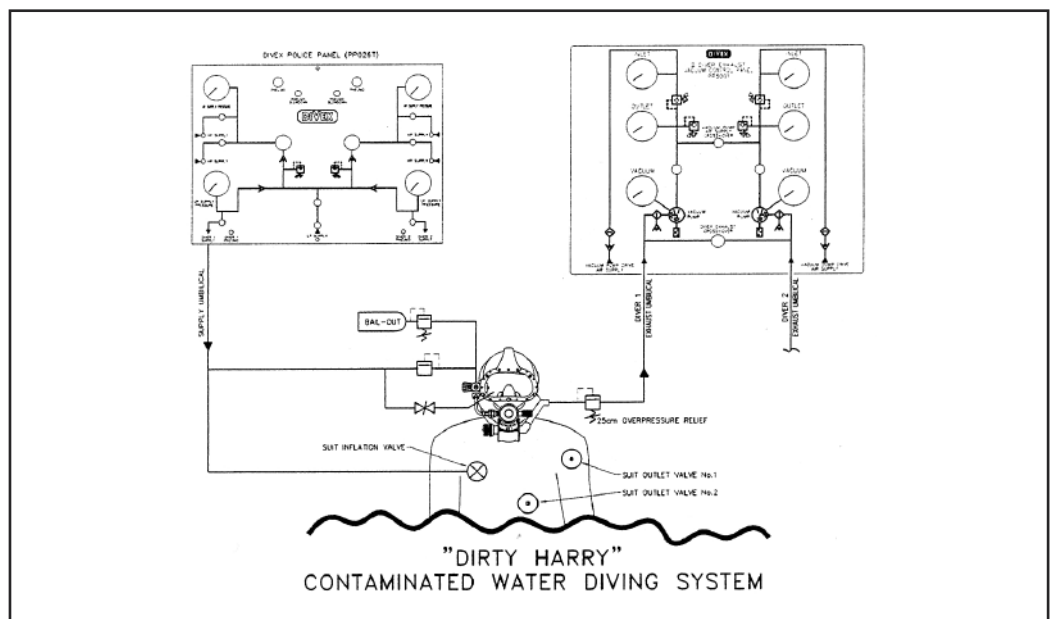
A chemical compatibility chart relating to the material types should be used to enable correct selection. Unless otherwise specified the suit supplied as the standard product is the polyurethane suit. This material has the advantage that it is easily cleaned and resistant to most hydrocarbons (common in harbours and many dive sites).

An inflation valve is fitted to compensate for squeeze. Two exhaust valves are fitted to relieve suit over pressure. One is fitted on the left upper arm. This would normally be used and adjusted.

As this is a common point of water ingress, Divex have incorporated a special pocket just behind the valve to accept super-absorbent material pads. The second valve is fitted centre lower chest, in case of failure of the first valve.

Gloves are available in a variety of materials and finger styles. The standard gloves supplied are 5-finger thick latex gloves with cotton liners. Additional thermal protection may be required depending upon conditions. The gloves are retained by a cuff-ring/'O'-ring combination (see manual).

**Note:** The drysuit cuff seal effectively seals off the glove in case of puncture of the glove material. However the gloves need to be pressure compensated to avoid squeeze. This normally occurs through leakage from the wrist seal into the glove but the user may wish to use a small diameter flexible tube to permit pressure compensation. Correct procedures are also required to ensure that the glove does not dislodge during ascent (see manual).





**PP032 Diver Control Panel:** The PP032 Diver Panel supplies gas from 4 high pressure sources and 2 low pressure back-up sources to 2 divers in the water. It is not included in the system but is recommended to companies or users who do not have a control panel.

Each diver has 2 dedicated high pressure (HP) supplies reduced via a regulator to low pressure. The two independent supplies allow switching of empty cylinders whilst diving. An additional low pressure (LP) supply is provided to supply the divers in case of lost HP pressure or regulator failure.

The divers depth is monitored via independent depth gauges. Communications permitting diver to surface and diver to diver two-way conversations is built in. A small tape recorder is fitted to record dive conversations - vital for those problem dives.

**Exhaust Control Panel:** The Exhaust Control Panel provides suction to the exhaust valve on the Ultrajewel 601 helmet. This ensures that the divers exhaled air is ducted away from the diver to the surface. At depths where the hydrostatic pressure is insufficient to vent the helmet unaided to the surface the vacuum assist is essential.

The Exhaust Control Panel is required to be used from the divers entry to the water down to depths of approximately 6-10 metres depending on umbilical length. The panel is required to be used at these depths both on ascent and descent.

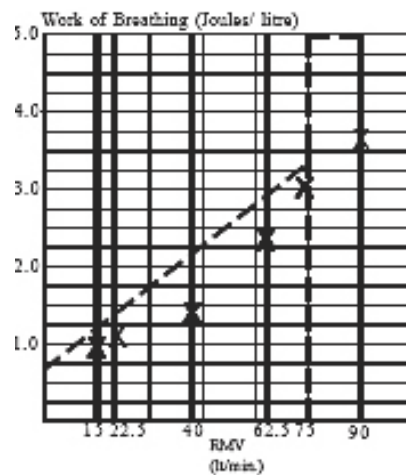
The panel is constructed of stainless steel and other low corrosion components and is furnished with all necessary filtration, controls and gauges.

### Test Data For 'Dirty Harry'

**Trial Depth:** 60 metres **Breathing Gas:** Air

Even at the extreme density of air at 60msw (equivalent to Heliox at 400msw) the helmet still performs exceptionally well.

The graph shows breathing performance of 'Dirty Harry' at breathing rates from 15lt/min to 90lt/min RMV. The Work of Breathing (measured in joules/litres) is compared to the dotted line denoting the maximum WOB permissible within the HSE/NPD Guidelines for Manned Underwater Breathing Systems.



Compliance with HSE/NPD Guidelines

**The System:** Each two Diver System consists of:

- 1 Two drysuits (one for each diver) - the suit material needs to be specified by the customer as does the sizes required.
- 2 Two pairs of dry gloves with lockrings (material to be specified).
- 3 Two Ultrajewel 17C Reclaim Helmets.
- 4 Two Umbilicals (Length to be specified), but normally 75m.
- 5 One Exhaust Control Panel.A

Adequate breathing quality diver gas and gas to drive the exhaust panel is required.

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