Appendix F: Horizontal Directional Drill Installation Manual

CaldwellMarine INTERNATIONAL
A JAG COMPANY

INSTALLATION MANUAL
FOR SEGMENTS 17 EM&CP
HORIZONTAL DIRECTIONAL DRILL (HDD)
AT PUTNAM STATION, CEMENTON and CONGERS

ON THE
CHAMPLAIN HUDSON POWER EXPRESS
SUBMARINE CABLE SYSTEM
20 FEBRUARY 2023

CALDWELL MARINE INTERNATIONAL LLC. 1333 Campus Parkway Wall Township, New Jersey 07753 **PROJECT CORRESPONDENCE**	**Type:** Project Correspondence **Prepared By:** Greg Horn, Thomas Ulisse and Shane Libbey **Document #:** 1229-02 3HDD IM_03 **Date**: 20 FEBRUARY 2023 **Revision No:** 3

DOCUMENT TITLE: INSTALLATION MANUAL FOR SEGMENTS 17 EM&CP HORIZONTAL DIRECTIONAL DRILLS AT SHORELINE CROSSINGS

APPROVALS:

Thomas Ulisse
Project Executive Caldwell Marine International

for NKT

Rev.	Description	Date	Approval
0	Initial Submission for Putnam Station, Cementon and Congers	09-20-2022	
1	Procedural updates for Congers. Plan and profile updates for all.	11-04-2022	
2	Updates from comment review	11-30-2022	
3	Updates from CRF SUB-0056	02-20-2023	

INSTALLATION MANUAL
FOR SEGMENT 17 EM&CP
HORIZONTAL DIRECTIONAL DRILL
AT STONY POINT

TABLE OF CONTENTS

TABLE OF FIGURES

LIST OF TABLES

TABLE OF APPENDICES

1.0 LIST OF ACRONYMS

ABS	American Bureau of Shipping
AC	Alter Course
AIS	Automatic Identification System
CD	Chart Datum
CHPE	Champlain Hudson Power Express Project
CMI	Caldwell Marine International, LLC
DGPS	Differential Global Positioning System
DP	Dynamic Positioning
DWT	Deadweight Tonnage
ECI	Environmental Crossing Inc. (d.b.a. Huxted Trenchless, LLC)
ECR	Equipment Calibration Record
EM&CP	Environmental Management & Construction Plan
EPP	Environmental Protection Plan
ERP	Emergency Response Plan
GA	General Arrangement
HDD	Horizontal Directional Drill
HDPE	High Density Polyethylene
HPU	Hydraulic Power Unit
HT	Huxted Trenchless, LLC
IMO	International Maritime Organization
ITP	Inspection and Test Plan
KP	Kilometer Point (along cable route)
LBE	Linear Belt Engine
LCE	Linear Cable Engine
LLW	Lower Low Water
MOP	Method of Procedure
OB	Over Board
PLC	Programmable Logic Controller (computer system)
QA	Quality Assurance
RLM	Running Line Monitor
ROV	Remote Operated Vehicle
RPL	Route Position List
SDO_2	Surface Decompression Oxygen
SOW	Scope of Work
UPS	Uninterruptible Power Supply
USBL	Ultra-Short Baseline
USCG	United States Coast Guard
VBS	Virtual Base Station
VHF	Very High Frequency
VTC	Vessel Traffic Control
WAAS	Wide Area Augmentation System

2.0 EXECUTIVE OVERVIEW

The work to be undertaken is associated with the State of New York Public Service Commission Case 10-T-0139 for the Champlain Hudson Power Express project for the construction of a 1250 MW high voltage direct current circuit from the Canadian Border to New York City. The cable route extends approximately 330 miles over land and marine pathways.

The EM&CP process for this project will be divided into multiple segments to allow for interim approvals, with directed notices to proceed (NTP) in support of the overall project schedule. This document is part of the quality plan and is an appendix to the Segment Seventeen Environmental Management & Construction Plan (EM&CP) submittal to NY Public Service Commission (NYPSC) pursuant to the Article VII permit for the Horizontal Directional Drills (HDD) at Putnam Station (Washington County), Cementon (Greene County), and Congers (Rockland County).

This document describes the methods and materials to be used for the HDDs prior to the cable installation in New York State, specifically:

- **Horizontal Directional Drilling at Shoreline Crossings - Segment Seventeen EM&CP (Putnam Station, Cementon, and Congers).**

A comprehensive quality assurance program has been developed to ensure that all phases of the program, from cable construction to installation and burial, are conducted in a controlled and predictable manner in full conformance with standard industry practices.

3.0 SYSTEM OVERVIEW

In support of the Champlain Hudson Power Express Project, *Caldwell Marine International LLC.* (*CMI*) has contracted with NKT Inc. to install 1250 MW HVDC submarine transmission cables. The transmission cables will connect New York City with Hydroelectric Power from the Canadian Border, see Figure 2-1. Transmission Supply Route. The transmission cables are divided into segments and will be spliced into one continuous length concurrent with their installation. The transitional HDD locations are summarized below. This Installation Manual will address the procedures and installation for the stated HDD locations.

- **HDD Location**
    - Shoreline Crossing in Putnam Station, NY, Cementon, NY, and Congers, NY to transition the submarine cable laid in the Hudson River to the approved underground route. Underground cable outside of the HDD on

land/terrestrial side will not be installed by CMI and will be covered in a separate EM&CP submitted by others.

- **Protection Strategies**
  - Submarine Cable installation procedures are covered in the Submarine Cable Installation Manual – Segment 5 furnished under separate cover, respectively.

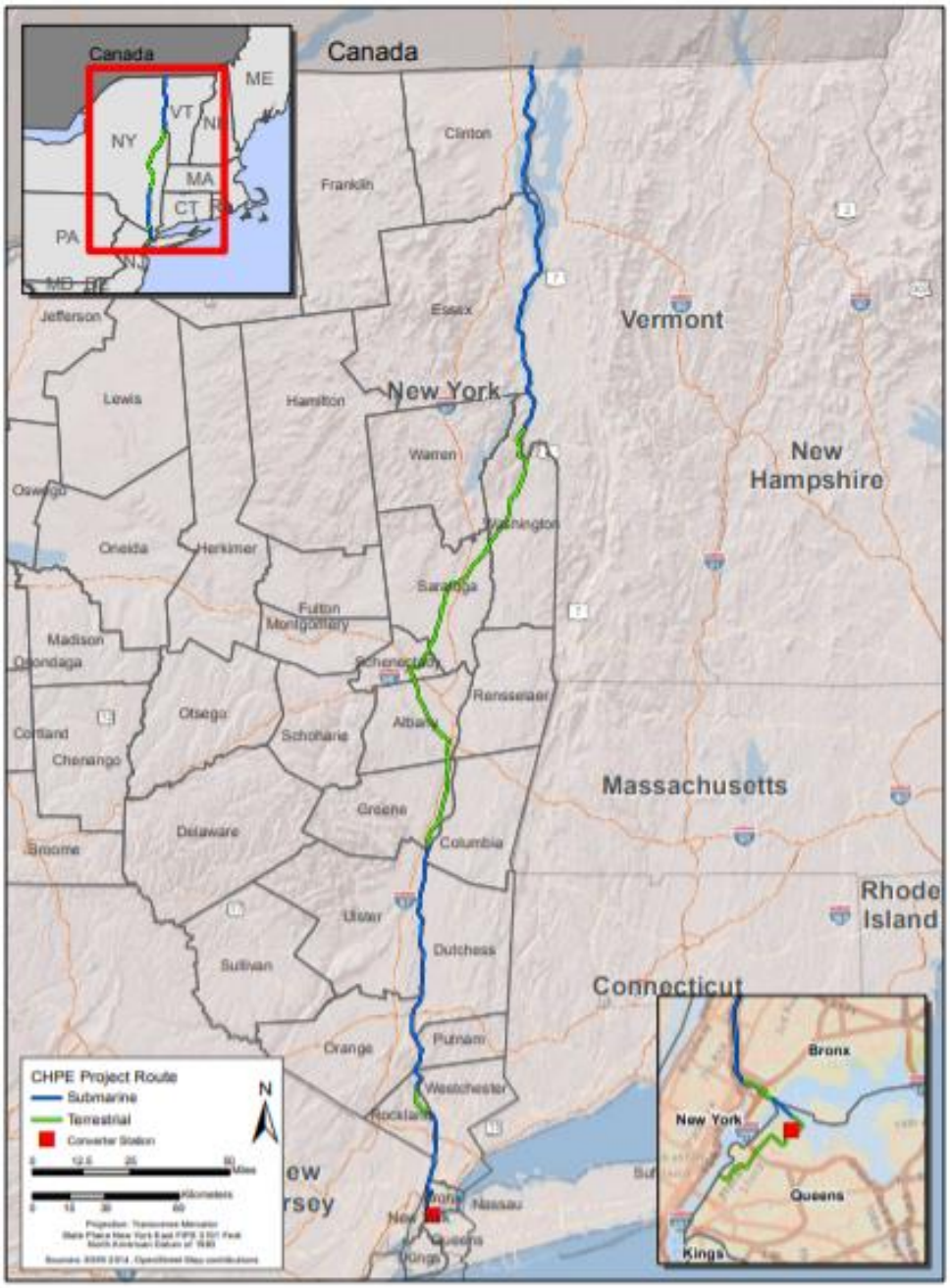


Figure 1 -*Transmission Supply Route*

4.0 SCOPE OF WORK – HDD

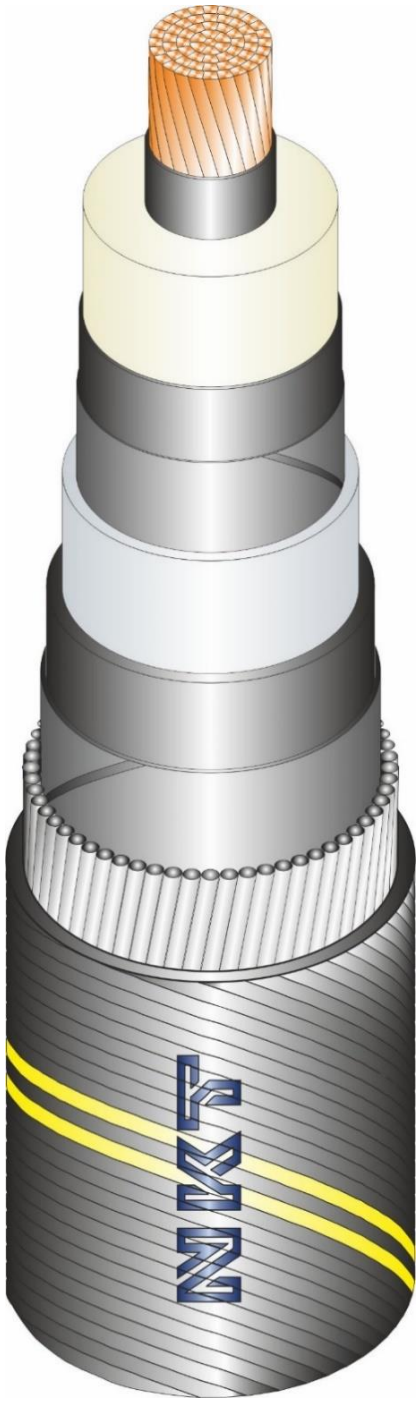
This installation manual provides a comprehensive description of the Horizontal Directional Drills to be performed as part of the infrastructure construction to be done in New York State, and is an appendix to the NY, EM&CP plan for Putnam Station, Cementon, and Congers. The document was prepared in accordance with the permits and plans that regulate this project including the NY Public Service Commission (Article VII) Permit for Case 10-T-0139.
This document is designed to be easily read in both paper and electronic formats. The document contains links to key figures, and embedded files. When printing or altering the file format of the document be sure to consider the embedded files.

This document is intended to explain the methods and procedures used to install two (2) 12” DR-09 High-Density Polyethylene (HDPE) pipes, approximately 900 lineal feet (LF) at Putnam Station, 800 LF at Cementon, and 2,500 LF at Congers. Construction is expected to take place during the Summer of 2023. Caldwell Marine International, LLC (CMI) will assist Huxted Trenchless, LLC (HT) with all offshore, marine support activities.

5.0 TRANSMISSION CABLES

The installation procedures and equipment are designed to comply with the mechanical and electrical characteristics of the transmission cable to be installed; therefore, a discussion of methods and materials is not complete without a description of the characteristics of the transmission cables.

5.1 Submarine Cable



DC Voltage	±400 kV	
Conductor	Profiled wires	
Type / material	Copper, Compound Water-Blocked	
Cross-section	4935 kcmil	2500 mm2
Water blocking	compound	
Diameter	2.28 in	57.8 mm
Conductor binder		
Material	semi-conductive swelling tape	
Thickness	22 mils	0.6 mm
Conductor shield		
Material	semi-conductive polymer	
Thickness	59 mils	1.5 mm
Insulation		
Material	cross-linked DC polymer	
Thickness	839 mils	21.3 mm
Insulation shield		
Material	semi-conductive polymer	
Thickness	55 mils	1.4 mm
Longitudinal water barrier		
Material	semi-conducting swell-able tape	
Thickness	26 mils	0.7 mm
Metallic sheath		
Type / material	extruded / lead alloy	
Thickness	118 mils	3 mm
Inner sheath		
Material	high-density polyethylene	
Thickness	98 mils	2.5 mm
Tensile armour		
Type / material	wire / steel	
Thickness	197 mils	5 mm
Outer serving		
Material	polypropylene yarn, 2 layers	
Thickness	157 mils	4 mm
Complete cable		
Diameter	5.44 inches	138.1 mm
Weight in air	36.4 lbf./ft.	54.2 kg/m
Weight in water	26.9 lbf./ft.	40.1 kg/m

Note: All data shall be considered nominal

Figure 2 *Submarine Cable*

Rated continuous DC voltage, U_0	400 kV
Switching impulse withstand level (SIWL) started from U_0	900 kV
Subtractive SIWL started from U_0 to voltage at opposite polarity	400 kV
Rated continuous current under the installation conditions	1,638 A
Maximum conductor temperature in normal operation	70 °C
DC resistance at 20 °C	0.0022 ohm/1,000 ft. (0.0072 ohm/km)
DC resistance at maximum conductor temperature	0.0026 ohm/1,000 ft. (0.0086 ohm/km)
Losses at rated current	7.6 W/ft. and cable (25.0 W/m)
Capacitance	0.081 μF/1,000 ft. (0.265 μF/km)
Inductance (between conductor and metallic sheath)	0.040 mH/1,000 ft. (0.132 mH/km)
Surge impedance	22.3 ohm

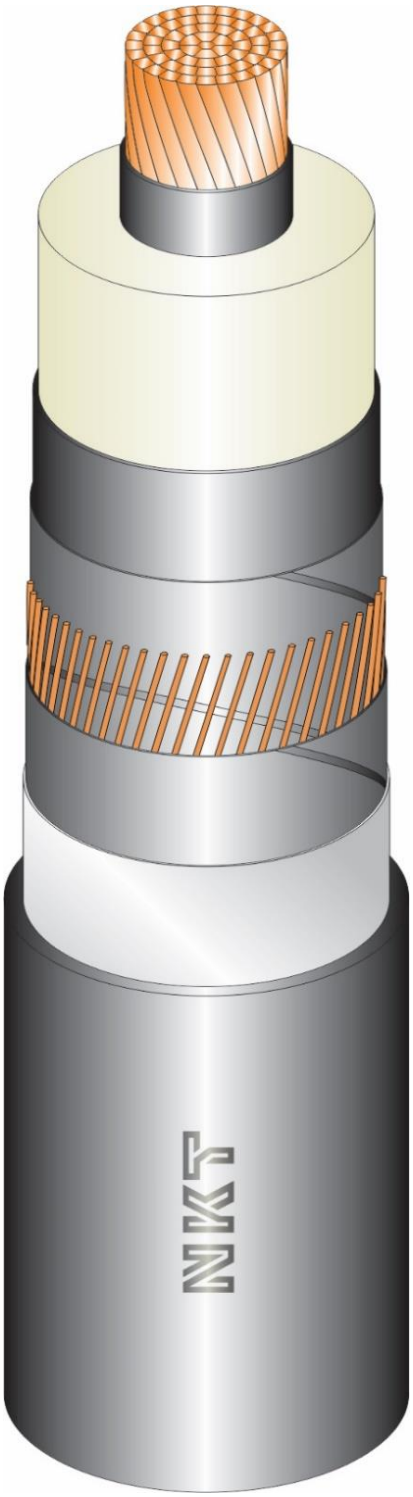
Table 1 Submarine Cable Electrical Data

Maximum Water Depth	400 feet (121.92 m)
Minimum bending radius	
- at laying (tension less than or equal 20 kN)	5.9 feet (1.8 m)
- at handling (tension greater than 20 kN)	6.9 feet (2.1 m)
- installed	5.9 feet (1.8 m)
Minimum bending radius for Chute	13.8 feet (4.2 m)
Minimum bending radius for turntable	6.9 feet (2.1 m)
Minimum coiling diameter 200 meters away from factory flexible joint	83 feet (25.3 m)
Minimum coiling diameter within 200 meters of a factory flexible joint	83 feet (25.3 m)
Maximum pulling force in conductor	
Straight Pull with conductor weld	54853lbs. (244kN)
Max permissible tension during bending MBR = 4.2 meters	47210lbs. (210kN)
Maximum side wall pressure $SWP = \frac{PullingForce}{BendingRadius}$	11240 lbs./ft. (50kN/m)

Table 2 Submarine Cable Mechanical Cable Properties

Full Technical Specifications for the Submarine Cable are illustrated in Appendix C

5.2 Land Cable



DC Voltage	±400 kV	
Conductor		
Type	Profiled Wire	
Material	Cu, Water-Blocked	
Cross-Section	4935 kcmil	2500 mm2
Diameter	2.28 in	57.8 mm
Conductor Shield/Screen		
Material	Semiconducting PE	
Thickness	59 mils	1.5 mm
Insulation		
Type	Triple Extruded, Dry Cured	
Material	XLPE	
Thickness	839 mils	21.3 mm
Diameter	4.11 in	104.5 mm
Insulation Shield/Screen		
Material	Semiconducting PE	
Thickness	55 mils	1.4 mm
Diameter	4.22 in	107.3 mm
Metallic Shield/Sheath		
Material	Semiconducting Swelling Tape	
Thickness	51 mils	1.3 mm
Type	Round Concentric Wires	
Material	Copper	
Cross-Section	150 kcmil	75 mm2
Longitudinal Moisture Barrier		
Material	Semiconducting Swelling Tape	
Thickness	53 mils	1.35 mm
Radial Moisture Barrier		
Material	Al-laminate	
Thickness	8 mils	0.2 mm
Jacket/Outer Sheath		
Material	HDPE	
Thickness	197 mils	4.8 mm
Conductive Layer	8 mils	.2 mm
Complete Cable		
Diameter	4.94 in	125.6 mm
Weight	20.9 lbs/ft	31.4 kg/m

All values should be considered indicative!

Figure 3-Land Cable

Rated continuous DC voltage, U_0	400 kV
Switching impulse withstand level (SIWL) started from U_0	900 kV
Subtractive SIWL started from U_0 to voltage at opposite polarity	400 kV
Rated continuous current under the installation conditions.	1,638 A
Maximum conductor temperature in normal operation	70 °C
DC resistance at 20 °C	0.0022 ohm/1,000 ft. (0.0072 ohm/km)
DC resistance at maximum conductor temperature	0.0026 ohm/1,000 ft. (0.0086 ohm/km)
Losses at rated current	7.6 W/ft. per cable (25.0 W/m)
Capacitance	0.081 μF/1,000 ft. (0.27 μF/km)
Inductance (between conductor and metallic screen)	0.040 mH/1,000 ft. (0.131 mH/km)
Surge impedance	22.2 ohm

Table 3 - Land Cable Electrical Properties

Weight of cable - in air	≈ 20.9 lbs/ft(31.4 kg/m)
Minimum bending radius - at laying - at handling (low tension) - installed	 7.4 feet (2.27 m) 5 feet (1.51 m) 5 feet (1.51 m)
Maximum pulling force	39342 feet (175 kN)
Maximum side wall pressure[1)]	1200 lbs./ ft.(17.5 kN/m)
[1)] SWP = Pulling Force / Bending Radius	

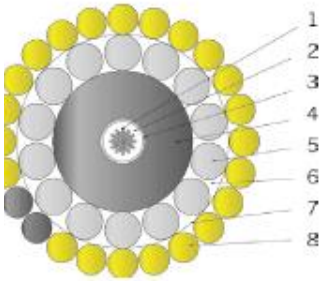
Table 4 - Mechanical Properties of Land Cable

Full Technical specifications for the land cable are illustrated in Appendix C

5.3 Submarine Fiber Optic Cable

ɲn

ıary coated fiber	Silica, acrylate
ıg compound	Thixotropic compound
ɛ	Stainless steel
ath	Polyethylene, black
ɔring	Galvanized steel wires, single layer 14 x ø3.0 mm
g compound	Bitumen
ɔping	Polyester tape
ɔping	Polypropylene yarns or HDPE sheath



Typical Data

Temperature range

Operation	-30 till +60°C
Storage	-40 till +70°C
Installation	-15 till +40°C

Maximum water depths

3000 m

Bend radius

No tensile load	≥ 0.5 m
With tensile load	≥ 1.5 m
Coiling	≥ 1.5 m

Dimensions

Diameter	22 mm

Weight

In air	1.1 kg/m
In seawater	0.8 kg/m

Tensile force

UTS	≥ 130 kN
FBL	≥ 130 kN
NTTS	100 kN
NOTS	70 kN
NPTS	50 kN

Crush resistance

≤ 10 kN/10 cm

Impact resistance

≤ 200 J

Mechanical and environmental test in accordance with IEC 60794-1-21 and IEC 60794-1-22

Electroding conductor

Electrical resistance	7 Ω/km

Figure 4 - *Submarine Fiber Optic Cable*

6.0 HORIZONTAL DIRECTIONAL DRILLING

Horizontal Directional Drilling (HDD) is part of the Marine Cable Installation for CHPE. This method statement contains a written interpretation of the construction methods and procedures planned by Huxted Trenchless, LLC (HT) to be endorsed prior to and during this project.

The drilling methodology and equipment is similar for the three installations, with the primary drilling equipment located on land for the Putman Station and Cementon HDD's and on marine barges for the Congers HDD. All three locations will utilize a temporary pile supported 30" diameter steel casing riser pipe in the water into the seabed that extends upwards on an angle onto the barge as the preferred method to capture the drilling fluid. In addition to this casing, an enclosed trench box (gravity cell) will be placed over each drill's exit location in the water to serve as a secondary means of confinement for any migrating drilling fluids. Since the drilling fluid is heavier than water, it will naturally collect in this gravity cell and can be easily pumped and stored on the barge should a breach at the steel casing occur. Sections of the 12" HDPE DR9 conduits are fused and de-beaded on land to form one continuous conduit string equal in length to each HDD. Once the bore hole is complete, the conduit is floated out in the water where it is pulled back to land with the drill equipment. Please see Appendix O of this document for further reference and detail.

6.1 HDD Overview

To facilitate the initial landing of the submarine cables, Horizontal Directional Drilling (HDD) will be employed to install two separate conduits commencing from the shore landing and ending in Lake Champlain (Putnam Station) and the Hudson River (Cementon, Stony Point and Congers).

- Putnam Station 2 Ea. @ 900 LF HDD 12" DR9 HDPE Conduits
- Cementon 2 Ea. @ 800 LF HDD 12" DR9 HDPE Conduits
- Stony Point 2 Ea. @ 2,400 LF HDD 12" DR9 HDPE Conduits
- Congers 2 Ea. @ 2,500 LF HDD 12" DR9 HDPE Conduits

The drilling aspect of the operation will be performed by Huxted Trenchless, LLC (HT). Caldwell Marine International, LLC (CMI) will provide marine support, permanent materials, supervision, and management of the operation. This installation manual is written for Putnam Station, Cementon, Congers. The methodology for Stony Point was provided in a separate Installation Manual and submitted under an earlier EM&CP submission.

6.2 Pre-Installation Procedures, Site Logistics, Environmental Considerations

6.2.1 Pre-Installation Procedures

As per the Marine Traffic Management Plan, prior to any marine activity, a Notice to Mariners will be issued to the US Coast Guard.

This will be accomplished by submitting to the US Coast Guard a narrative description along with a drawing of intended vessel/barge layout, together with details of the work including but not limited to work hours, safety lighting plan, anchor plan, etc. Work barges to be utilized are intended to have spud anchor systems. Upon notice of start of work to the US Coast Guard, the NY Port – District 1 will issue a Notice to Mariners for the specified duration of the work.

Caldwell Marine International shall post standard day shapes and lighting in accordance with the USGC regulations concerning vessels limited in their ability to maneuver and or vessels at anchor. Furthermore, CMI vessel crews shall maintain daily communications with Vessel Traffic Control and all commercial vessels in the area.

Prior to the start of operations all existing utilities will be marked and mapped on the site plan. One Calls per 16 NYCRR 753 (Protection of Underground Facilities) and contact with private landowners will be used to ensure all existing utilities are well marked. The drill entry and exit locations will be staked out. The immediate area occupied by the HDD spread will be surrounded by a silt fence per the approved SWPP plan. Silt fence material to meet NYSDEC standards and to be installed per manufacturer's instructions.

6.2.2 Site Logistics

- Access to the site(s) will be via the public Roads and ROW's, and defined access roads. Access across or onto private property will be done in accordance with permissions and easements provided by Owner.

- No topsoil stripping will be allowed. The access road will be constructed from ¾" clean stone – 6" thick placed over a bed of filter fabric. The access road follows the path of an existing driveway; therefore, terrain is favorable, and no earth grading is needed to prepare same.

- Parking, if not provided on site, will be as shown on drawings for approval.

- The site will be secured by temporary construction fencing furnished by CMI, and the access gate(s) will be locked, rendering the site inaccessible to the general public.

- CMI and HT will have safe and unfettered access to the installation locations at any time.

- Construction Traffic during Mobilization is expected to be:
    - Approximately 6-8 Standard over the road Tractor and Trailers. The Tractor and Trailers are anticipated to arrive over the course of 3 days.
    - The Drilling Rig and Mud System will require over the road permits, special Permits are not anticipated for additional loads. HT and CMI will handle permits associated with the transportation of our equipment.
    - Approximately 9 Pickup/Utility trucks approximately 2-3 trips each day.
    - No disruption to local traffic is expected

6.2.2.1 Maintenance and Protection of Traffic (MPT)

Prior to the start of the planned operations for the Horizontal Directional Drills (HDD), CMI will implement traffic management measures in accordance with the New York Department of Transportation standards for the Putnam Station HDD. Notification for construction and road closure signage, as well as Type-III barricades will be installed along State Route 3 in advance of the planned HDD construction area and planned drill entry location. MPT is not required for the Cementon HDD as the construction activities will be conducted on private property under an Owner's property agreement and easement. MPT will be implemented for the Congers HDD to alert motorists travelling along Route 9W for construction vehicles entering and exiting the planned Congers HDD location at 'Clarkstown Carting Associates, Inc' at 142 Route 9W, Congers, NY 10920. Please reference Appendix R for typical traffic control notes as well as the planned road closure (Putnam Station) and shoulder closure (Congers).

6.2.2.2 Construction Traffic during Operations

- Workers coming to and from the site each day
    - Approximately 9 Pickup/Utility trucks approximately 2-3 trips each day
- Inspectors visiting the site
    - Anticipate one car one round trip per day
- Fuel delivery by tandem axle truck one round trip once daily, or, every two days, as needed.
- Disposal of HDD Cuttings by tandem axle truck one round trip every two days
- Miscellaneous unexpected deliveries and or inspections with passenger car / pickup.
- No disruption to local traffic is expected

6.2.2.3 Nighttime Construction Provisions

- Operations are expected to be during both daylight hours and nighttime operations (as schedule requires).
- During nighttime operations, generators and area lighting will be used.
- For noise sensitive areas, a sound barrier will be utilized.

6.2.3 Environmental Considerations for HDD

- The site will be kept in a neat and orderly manner and all trash and debris will be removed as appropriate. It will be transported and disposed of by an approved trash service provider.
- Fugitive Dust and Airborne Debris Control measures are not anticipated to be required
- HDD entry pit will be stabilized with earthen berms and straw bales
- Work area will be surrounded by a silt fence
- Soil Management Plan
- Stockpiled Soils (drill entry pit & Deadman anchors)
    - Small stockpiles approximately 3 yd^3 each will be located adjacent to entry pits
        - Material will be protected from run-off
        - Approval / Acceptability: Appendix F describes the criteria used to determine which location the excavated material will be transported to for processing and possible reuse.
            - Material must meet acceptability criteria at the facility and comply with local, state, and federal regulations as well as facility permit requirements. Contractor will provide a completed non-hazardous profile sheet, sampling diagram, appropriate analysis per facility permit requirements and additional certifications as required.

6.2.3.1 HDD Cuttings

- HDD cuttings will be separated from the drilling fluid and stored in 20 yd^3 containers. Since the cuttings are wet the 20 yd^3 container will be filled with 10 yd^3 of material so that the weight is manageable without the need for special permits.
    - Installation of a 1,000-foot crossing of 12-inch pipe will produce approximately 65 cubic yards of drill cuttings. There will always be two containers on site for storage and removal of the drill cuttings. The maximum volume of cuttings to be stored on site at any time will be 40 cubic yards.

- Material will be disposed of accordingly.

- Approval / Acceptability.
- Material must meet acceptability criteria at the facility and comply with local, state, and federal regulations as well as facility permit requirements.
- Please refer Appendix F – Drilling Fluid Containment Plan and Erosion/Mud Control Plan (Inadvertent Returns).
- Mud disposal tickets will be collected for project record and provided via submittal, as required.

6.2.3.2 Drilling Fluids

- Drilling fluids will be kept on-site during the entire drilling operation, as they are continuously being re-circulated and processed for re-use in the boreholes using a closed loop system.
- Groundwater Dewatering is not anticipated
- Sound attenuation will be utilized as and where required by project specific noise study to meet local and jurisdictional noise ordinances, and as detailed in Appendix L of this document.

6.2.3.3 Fuel Storage & Refueling (Appendix F, Paragraph 4.2)

- All fuel will be stored in the machineries built in tanks
- Machinery will be refueled from a fuel supplier. Additional fuel may be stored in an approved and properly bonded fuel storage cell, located on site.
- Fuel will be transferred in accordance with the fuel supplier's plan.
- Contractor will ensure that at least two of its people will participate/ observe fueling operations.
- At least one person will always man the pump's shut off valve.
- All hose joints (if used) will be observed during fueling for any leaks.
- Spill response kits will be on site and readily available.
- Fire extinguishers will be on site and readily available.
- Site Clean up
    - The site shall be returned to a clean state.

6.3 HDD Personnel and Equipment

6.3.1 Personnel

The supervisory personnel proposed by HT on this project have an average 20 years' experience in HDD. All the supervisory personnel have worked on underwater exits in the HDD industry.

A list of the personnel, including key personnel and resumes will be provided as part of this installation manual prior to commencement of each HDD.

Drill Crew (per shift):

(Congers Drill site will be completed using the intersect method for steering. A drill spread will be located on land and on a barge near the exit location. The crew size will be double at the Congers location.)

Superintendent	1
Driller	1
Mud Operator	1
Heavy Equipment Operators	2 - 4
Drill hands	2 - 4
Driver	1
Steering Engineer	1

6.3.2 Equipment

1. Drilling Rig (minimum 240,000 lb push/pull)
2. Mud Systems (147 BBL capacity each)
3. Mud Pumps 446 (325-350 gpm)
4. Control Cab (10' x 8')
5. Vac. Trailer
6. Excavator & Track Hoe
7. Frac-Tanks
8. Tool Van
9. 6-inch transfer pumps

6.4 Typical HDD Construction

6.4.1 Pre-Construction Survey

A surveyor, on behalf of Huxted Trenchless, LLC, will arrive on site prior to the arrival of the equipment. The surveyor will layout the centerline(s) of the crossings and install the surface tracking system for all drills where needed.

6.4.2 Rig Up

The drilling spread will arrive on site in a predetermined order and will be assembled and set up according to the site layout**.** A small 6'x6'x4' pit will be excavated at the drill entry; the excavated soil (approximately 3 yd^3) will be stockpiled (adjacent to the entry pit) and or used to build a berm surrounding the drill entry pit, additionally straw bales will surround the drill entry pit, followed by orange safety fencing.

To secure the drill rig temporary Deadman anchors will be placed and consist of steel I-Beams driven in the ground.

6.4.3 Pilot Hole

The bottom hole assembly (BHA) for the pilot hole will consist of a tri-coned Drill Bit connected to the jetting assembly and Non-Magnetic Drill Collar containing steering probe and extend about 40 feet behind drill bit. The Non-Magnetic Drill Collar will be connected to the steel drill pipe utilizing the bolt-on connector. Soil borings collected (Appendix T) have determined a harder rock formation for both the Cementon and Congers HDD locations and thus requiring the use a mud motor and rock reamers.

The pilot hole will enter the ground at the predetermined entry point and will follow the design path in both the profile and plan view. This will be accomplished by utilizing the tracking information established by the surveyor along with the calculated information received from downhole steering equipment.

Prior to exiting in the river bottom, the entire drill string will be flushed with fresh water to the eliminate the drilling mud from entering the water on punch out. Once the bit and steering tool has exited, a dive crew will assist in bringing the drill stem up to the working barge using a winch and tag line. On the Congers Drill, a second drilling rig will be on a barge and the pilot hole will start within the casing previously installed in the river. This crossing will be completed using the intersect method. The pilot hole is drilled from both directions and meet, completing the bore path. The pilot hole assembly is removed, and the drill pipe is re-attached to the winch line. A Conductor Casing will remain over the entry hole and embedded into the river bottom – essentially extending the bore hole through the water column to prevent any loss of drilling fluid during the drilling operations. In addition, a gravity cell is set over the exit location to capture any residual drill fluid that might escape. See Appendix O of this document for further detail.

6.4.4 Transition Pilot Hole to Ream/Pullback

For the Putnam Station Drill and the Cementon Drill, the drill crew will install an 18” reamer at the rig on land and ream towards the water and barge. This is commonly called forward reaming and will force most mud back to the drill entry location on land. However, for the Congers Drill, the elevation on land is significantly higher than the water and forward reaming from the land is not recommended. As such, for the Congers Drill, HT will place will use a pull ream method, pulling the reamer with the drill rig on land up hill to the work area. The drilling fluid will naturally (gravity) return to the barge via the conductor casing previously installed the water. The drilling fluid is then recycled on the barged and reused in the same manner as if the drilling equipment was located on land.

6.4.5 Reaming

While reaming, the drill rig will exert minimum push pressure on the reamer allowing the rotary torque to dictate the penetration rate. For the Putman Station Drill and the Cementon Drill, a winch and cable system located on the barge and connected to the drill steel will assist pulling the reamer through the bore hole. For the Congers Drill the land rig will provide the needed pull force to advance the reamer from the water to the

land. In both cases, the operator of the winch, second drill rig or excavator will be in constant contact with the drill operator to ensure the proper pulling force is always applied. As each new section of drill pipe is installed at the drill rig and the reamer is advanced, a crew located at the far end will be removing a section of drill pipe.

6.4.6 Swabbing

After the hole is reamed, HT will swab the hole. The swab pass is used to clean out the bore hole and make sure it is conditioned properly to accept the proposed HDPE product pipe. This might include multiple passes to make sure the reamed hole is free of any obstruction before pullback. HT intends to swab all the bore holes from water to land (same direction as the HDPE product pipe installation) with a 14" barrel reamer.

6.4.7 Ream/Pullback

During the drilling and reaming process, a separate crew will be fusing, de-beading and mandrel testing the HDPE product pipe onshore. A marine support crew will tow the assembled product pipe offshore and line it up with the exit location. The coast guard will be notified prior to launching the HDPE conduit string into the water. When the product pipe reaches the exit location, it will be mechanically connected to a swivel and lifted above the barge to be pulled into the bore hole. The marine support at this time will be on constant patrol of the floating HDPE pipe.

Pullback will continue, uninterrupted, as drill pipe is removed at the drill rig located on land. Once the product pipe has reached the entry/exit pit, the pulling assembly will be removed, and the pipe allowed to relax. The product pipe will be proofed and pull line installed for future cable pulling operations.

6.4.8 Rig Down/Demobilization

Once the product pipe has been successfully installed, all equipment, mud, cuttings, and debris will be removed from the work site. The used drilling fluid and cuttings will be hauled and disposed of at an approved facility. The work area will be returned to pre-drill conditions for final restoration.

6.5 HDD Marine Support

The marine support for the HDD operation will consist of the following activities:

- Support barge(s) with a crane for all drills.
- Jack-up barge for drilling equipment at Drill #4 - Congers
- Dive support for recovery of the down hole tooling
- Affix the HDPE conduit string to the reamer assembly
- Connect the reamer or HDPE assembly to the drill string
- Support for the reaming operation
- Handling and feeding of the HDPE conduit(s) into the HDD bores
- Clean up and disposal of surplus offshore drilling fluids

6.5.1 Marine Support Equipment

- Deck Barge with Spuds
  - 150–200-ton Crane
  - ICE 416 & HPSI 400 Vibratory Driver / Extractor
  - Environmental Clamshell Bucket
  - Generator
  - Tool Room
  - SDO2 Dive Spread
  - Broco Underwater Burning Rig
  - Diesel Welder
  - Deck Lighting
  - Emergency Spill Response Kit
  - Porta-John
  - Office Trailer
  - Lunchroom
- Materials Deck Barge – as required
- Jack–up Barge
- Scow Barge – as required
- Tugboat - as required
- Work Skiffs

6.5.2 Fusing Support Equipment

- HDPE Fusion Machine
- Generator
- Excavator

6.5.3 Land Support Equipment

- Office and tool trailers

6.5.4 Permanent Materials

- 12” DR9 HDPE Pipe (conduit) in 50’ lengths

6.6 Procedures for Marine Support

6.6.1 Recovery of Down Hole Tooling

After the drill head has penetrated lake or river bottom, divers will locate and connect the tooling to the crane on the support barge. The crane will take up the load until the tooling is recovered on the deck of the support barge. Once on deck, the tooling can be removed or replaced as needed to complete the HDDs.

6.6.2 Reaming / Pullback

CMI will assist with the connection or removal of the reamers and HDPE conduit string assembly. For the pullback operation, CMI will provide direction and assistance for the pull back and to ensure that the trailing end of the HDPE conduit is pulled below the lake or river bottom to the desired depth.

6.7 Procedures for Land Support

6.7.1 HDPE Fusion

The HDPE conduit will be delivered by truck in (50’ lengths) and stored at each staging yard local to the respective drill site. CMI’s intention is to fuse the conduit at the staging yard in one continuous length. Each of the HDPE strings will be approximately; 900 LF for Putnam Station, 800 LF for Cementon and 2,500 LF for Congers. The fusion machine and generator will be staged in a strategic location in each staging area and the HDPE segments will be moved to the machine for fusion. CMI will have the HDPE manufacturer supply a representative to QC the operation. After the bore hole is swabbed, the HDPE pipe will be launched and towed to the HDD exit location for pullback. The coast guard will be notified prior to launching the HDPE conduit string and movement of the same from waterside to site. A Notice to Mariners (NTM) will be issued.

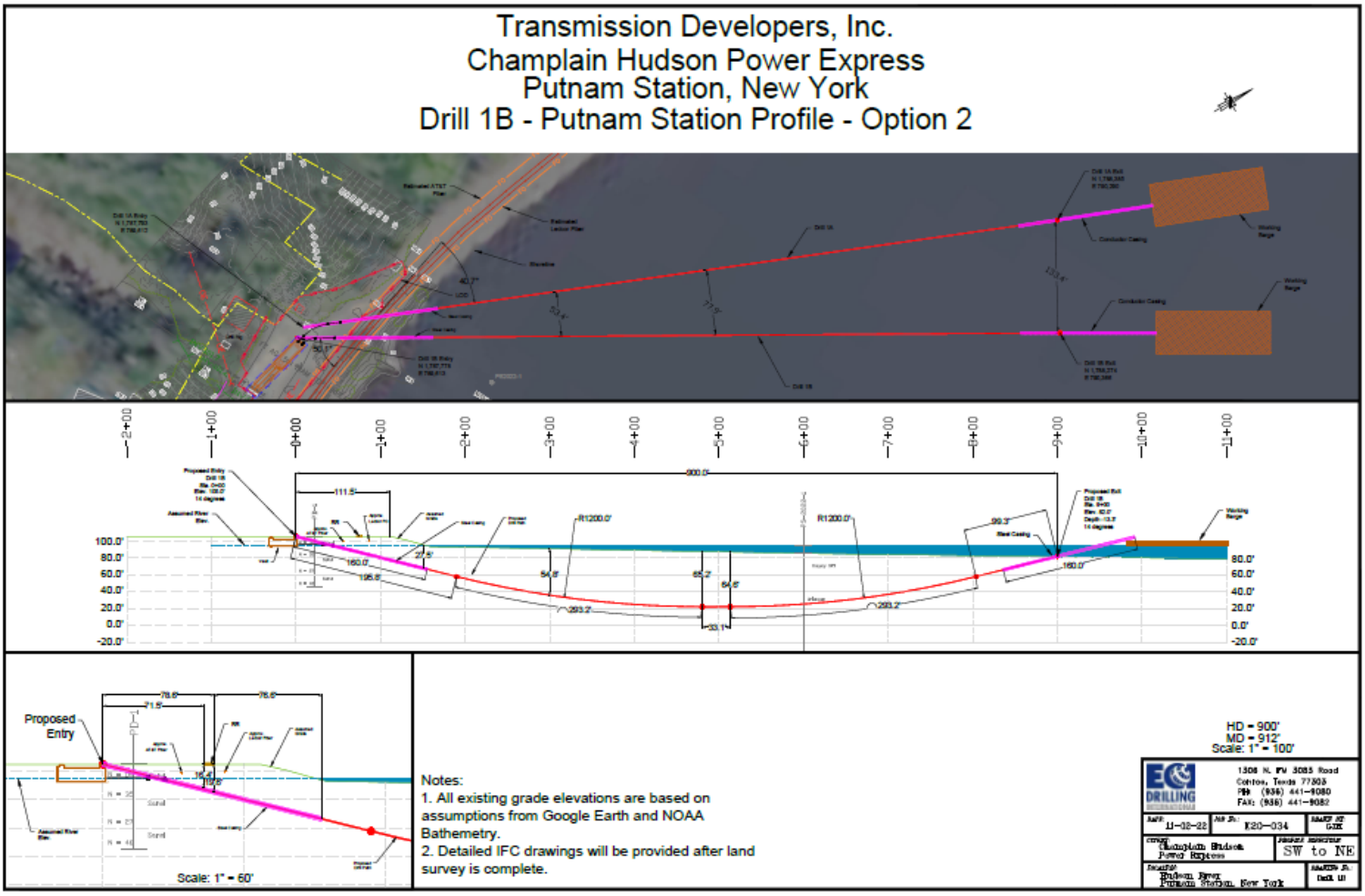


Figure 5 HDD Plan and Profile Drill - Putnam Station, NY

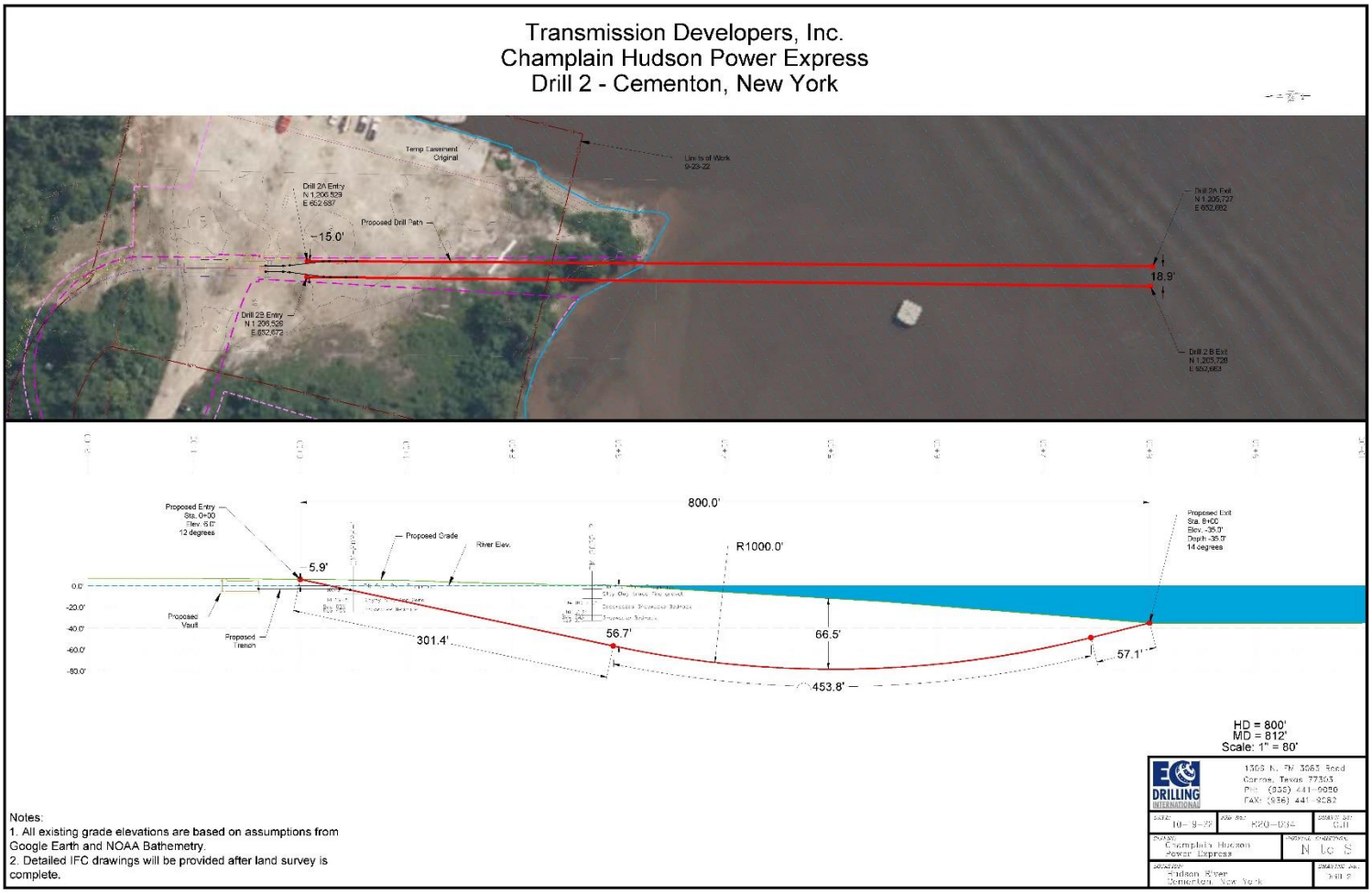


Figure 6 HDD Plan and Profile Drill - Cementon, NY

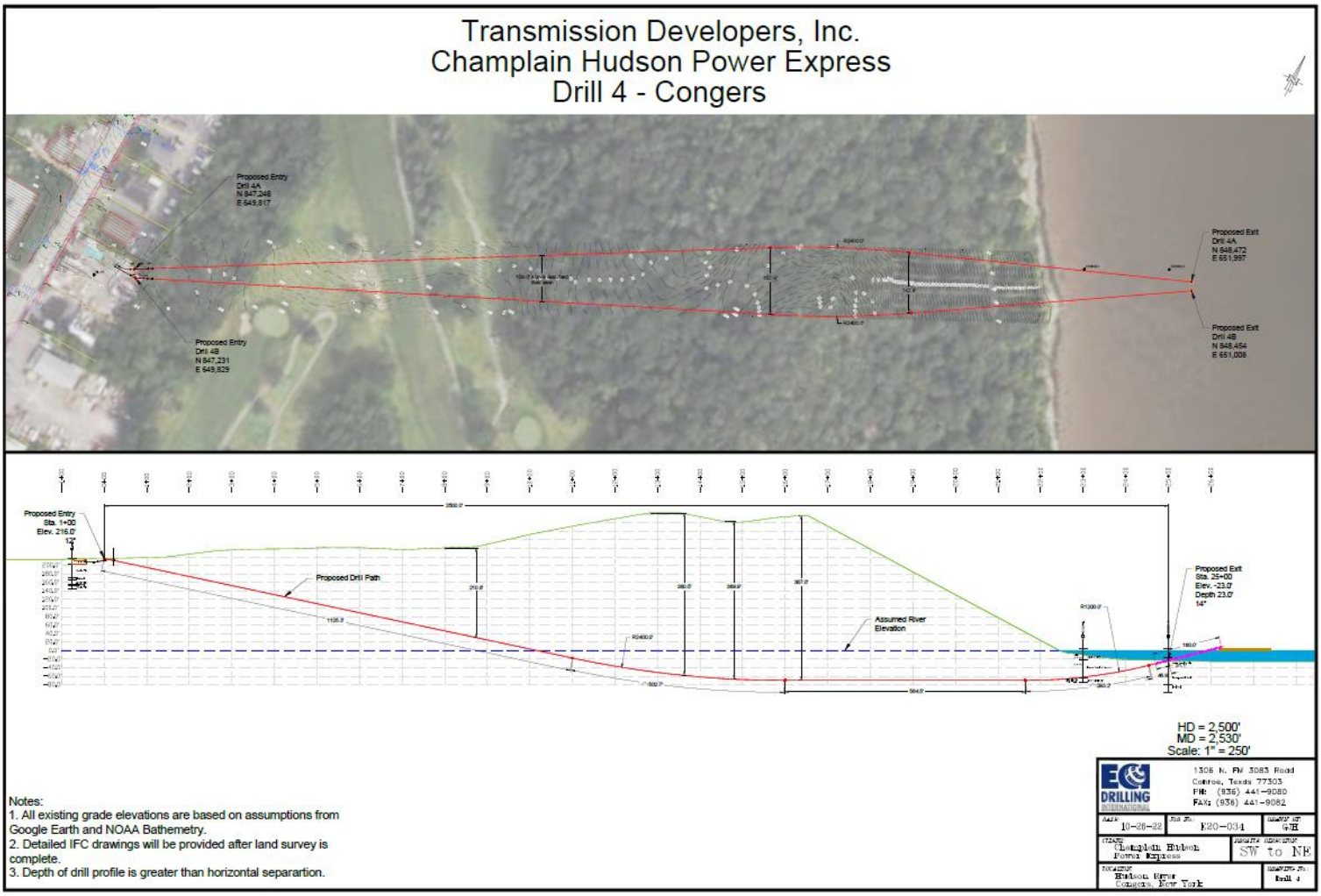


Figure 7 HDD Plan and Profile Drill - Congers, NY

7.0 INSTALLATION QUALITY ASSURANCE

This section describes *CMI*'s quality assurance system, from project organization to task-oriented Inspection and Test Plans (ITP's), calibration methods and reporting procedures.

7.1 HDD Shoreline Crossings Project Organization

The *CMI* organizational chart for the HDD Shoreline Crossing Work is shown in **Figure 8**. The responsibilities of each key member of the installation team are described below in Table 5. *CMI* Organizational responsibilities.

Position	Responsibility
General Manager *Brett Bailey*	Reports to the Executive Vice President, and oversees the management, execution, and financial aspects of the project.
Project Executive *Thomas F. Ulisse*	Reports to the General Manager and is responsible for the overall management of the project. The Project Executive oversees and controls the performance of the work. He is responsible for project coordination, liaison with the Client, and for all financial, logistic, quality assurance and safety aspects of the work.
Equipment Manager *John S. Gutierrez*	Provides project support, and coordinates directly with the Project Manager and Superintendent. The Equipment Manager is responsible equipment resources.
Operations Manager *Ed Phillips*	Provides project support and is responsible for the performance of the work. The Operations Manager reports to the General Manager.
Cable Superintendent *Paul Larrabee*	Provides project support and reports directly to the Cable Division Manager.
HDD Operations Manager *John Langford*	Provides project support for HDD operations and reports directly to the CMI Operations Manager.
Project Engineer *Dominic Palermo*	Provides project support and reports directly to the Contract Executive.
Brett Bryant *Adam Brown*	Responsible for the daily work and reports directly to the Superintendent
Health & Safety Officer *Lucky Abernathy*	The Health & Safety Officer is tasked with ensuring that all aspects of the *CMI* Safety Plan are followed. He reports directly to the Project Superintendent.

Table 5 - *CMI Organizational Responsibilities*

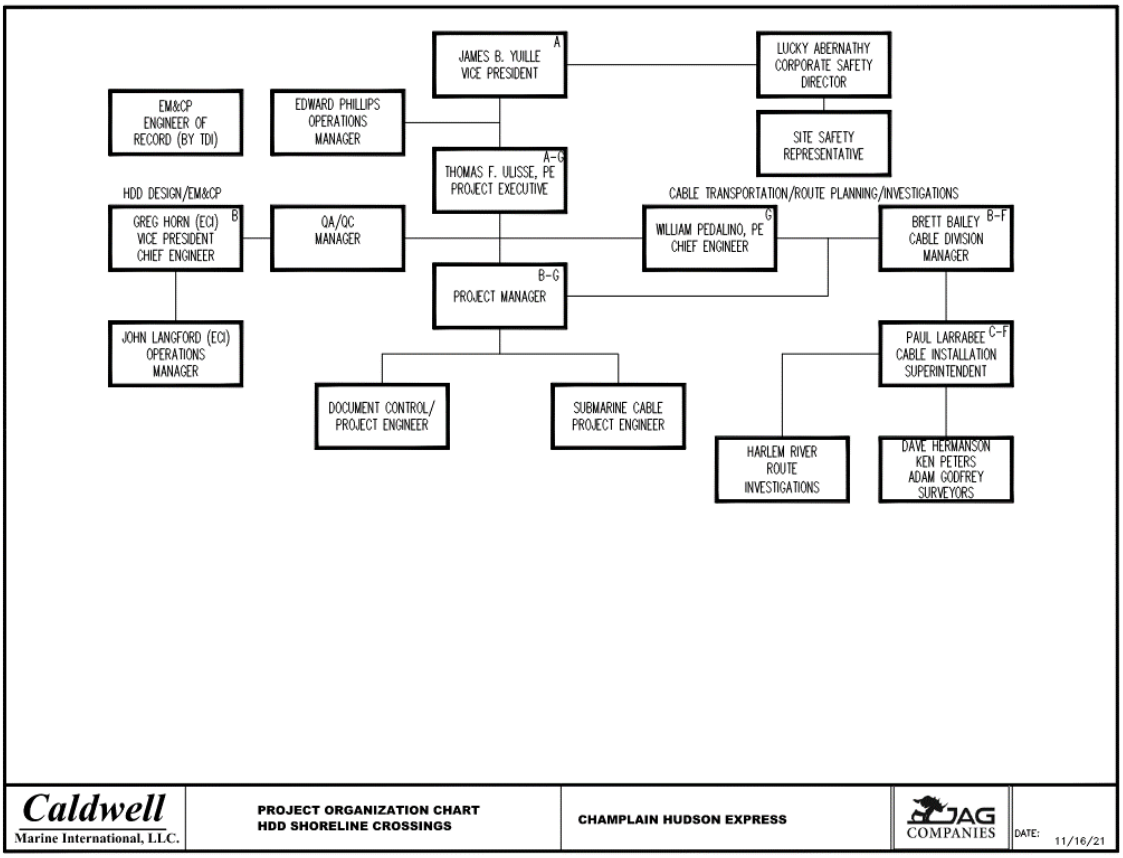


Figure 8 CMI Project Organizational Chart

7.2 Daily Reporting

A sample Daily Operations Report (DOR) format is included in Appendix A. A copy of this report will be submitted for signature to the on-site representative daily by the *CMI* Field Project Superintendent. A second DOR will be completed when concurrent work is being done and the logistics make one report impractical. The signed reports will then be e-mailed to the respective project parties daily, after operations are completed, or at the soonest opportunity.

7.3 Milestone Meetings

Periodic meetings will be held by the *CMI* Project Manager at specific milestones in the operation. These meetings will be held to review procedures for the specific task to be accomplished and, if the task is repetitive, to review previous procedures with the aim of improving the procedure.

7.4 Installation Inspection and Test Plans (ITP)

Installation and Test Plans (ITP) are part of the quality control monitoring system. ITPs are included in Appendix I. The Inspection plan shall include verification of depth of the HDD conduit following installation to prove that it meets the required burial depth of submarine cable of 4' for the Putnam Station segment in Lake Champlain and 7' for the Cementon and Congers segments in the Hudson River.

7.5 Calibration Methods

The gyro will be calibrated prior to use in the HDD work.

7.6 Contingency Plans

The best contingency plan is to plan ahead to avoid emergency situations. Planning includes following a thorough equipment maintenance plan, monitoring weather forecasts and planning activities accordingly, and reliance on past experience to avoid situations that could require the use of a contingency plan. The following section describes the options available in the event of specific system failures.

7.7 Non-conformance Reporting Process

CMI has developed a non-conformance report format to document non-conformances to the specifications. The non-conformance report includes proposed disposition and/or corrective actions taken to remedy the non-conformance. A sample non-conformance report is attached in Appendix G.

7.8 Marine Traffic Management Plan

Standard *CMI* policy is to issue a Notice to Mariners prior to commencement of any marine work at each respective HDD marine support location. *CMI* guidelines for marine work follow standard industry practice.

8.0 ENVIRONMENTAL ASPECTS

8.1 Weather Operational Limits

CMI will consult the publicly available weather forecasts and tidal forecasts daily for the planned operations. Examples of these forecasts and reports are provided in Appendix J of this document. Estimated operational limits for specific phases are shown in Table 6, maximum operating limits for wind speed at wave height will vary depending on the direction of the wind and waves. These are only estimated operating windows

and the actual maximum wind speeds and wave heights are highly dependent on the location of the site relative to the wind and wave direction.

Should conditions exceed the operating windows the course of action will be decided on-site by the supervisor in charge of each task.

PHASE	SUPERVISOR	ESTIMATED MAXIMA	
		Wind (kts)	Wave Ht (ft)
Marine Work	Superintendent	15 – 20	<2.5ft
Land Work	Superintendent	20-25	NA

Table 6 - Estimated operating weather parameters for the marine installation

8.2 Environmental Considerations

CMI will ensure that all work is completed in accordance with the permits, the forthcoming Environmental Monitoring and Construction Plan (EM&CP), the USCOE permit, and common industry practices.

8.3 Environmental Monitoring and Sampling

Environmental monitoring and sampling where required by any operation, permit, or regulatory authority will be completed by other third parties with the understanding that the results of analysis generated from any sample collection will be made available within a timely manner.

8.4 Cultural Resources

Archaeological work is not anticipated during this project, however, should archaeological materials, including human remains, be encountered during construction, CMI will stabilize the area and cease construction activities in the immediate vicinity and contact the CMI and NKT Project Managers and the CMI Project Executive.

8.5 Spill Prevention

CMI has developed a comprehensive spill prevention plan designed specifically to prevent spills in marine operations. The plan can be found in Appendix E (Spill Prevention Plan).

9.0 APPENDICES

Appendix A– Daily Operations Report

1229 – Champlain Hudson Power
Express Daily Operations Report
DOR: 10
Tuesday, January xxth 20xx
Client: NKT

CMI Representative	CMI	Email address
CMI Representative	CMI	
CMI representative	CMI	
CMI Representative	CMI	
CMI Representative	CMI	
CMI Representative	CMI	
NKT Representative	NKT	

A. Summary of Activities to Date:

- Support of Manholes 7 & 8

B. Today's Activities:

- Welding of Manhole Covers

C. 5- Day Look Ahead:

1/16/19	Demobilization

D. Safety:

	Today	Cumulative	
Incidents	0		
Accidents	0		
Near Miss Events	0		
Safety Meetings	0	0	

E. Weather:

Time	Wind Dir.	Speed MPH	Vis (mi)	Temp	Conditions/ Remarks
0600	S	8	10	34	Partly Cloudy
1200	S	6	10	37	Partly Cloudy
1800	S	6	10	34	Partly Cloudy

F. Diary of Events:

Time	Activity
0800	Start of Shift
0830	Setup at Manholes
830-1930	Support of Manholes
2000	End of Shift

G.CMI Personnel on Site:

	Name	Title	ST	OT	DT	
1						
2						
3						
4						

H. Equipment:

EQ #	Description	Location	Owner
	1997 Ford F-800 22’ Box Truck		NRC
	(50) Traffic Cones		NRC
	(2) Manhole protection rails		NRC
	(2) 16’ extension ladders		NRC
	Powerwasher		NRC
	(2) portable generators, one with light stand attached		NRC
	(3) 2” submersible pump		NRC
	(1) 300 gallon empty water tank		NRC
	Windmaster signs: (2) arrows, (4) Road Work Ahead, (2) Merge Right, (2) Merge Left, (1) Flagman Ahead		NRC
	(2) Stop/Slow traffic paddles		NRC
	(30) Traffic Cones		CMI
	(2) 2” Trash Pumps		CMI

Contractor Comments: Welding of

Manholes Client Comments:

CMI Representative ***Client: _ Caldwell Marine Int.OCUA***

Appendix B– HDPE Specifications

FORTILINE
HDPE FUSION GROUP
a MORSCO brand

Iron Pipe Size (IPS) and Dimension Data — PE4710

Pipe for Municipal and Industrial Applications

Pressure Ratings are calculated using 0.63 cesign factor for HDS at 73°F as listed in PPI TR-4 for PE 4710 materials. HDPE can accomodate up to 1.5 times the pipe pressure rating for a recurring surge and up to 2.0 times the pipe pressure rating for an occasional surge. Temperature, Chemical, and Environmental use considerations may require use of additional design factors.

Pressure Rating		335 psi DR 7.0			250 psi DR 9.0			200 psi DR 11.0			160 psi DR 13.5			
Nominal Pipe Size	IPS OD (in)	Minimum Wall (in)	Average ID (in)	Weight (lbs/ft)	Minimum Wall (in)	Average ID (in)	Weight (lbs/ft)	Minimum Wall (in)	Average ID (in)	Weight (lbs/ft)	Minimum Wall (in)	Average ID (in)	Weight (lbs/ft)	Nominal Pipe Size
1 1/4"	1.660	0.237	1.158	0.46	0.184	1.270	0.37	0.151	1.340	0.31	0.123	1.399	0.26	1 1/4"
1 1/2"	1.900	0.271	1.325	0.61	0.211	1.453	0.49	0.173	1.533	0.41	0.141	1.601	0.34	1 1/2"
2"	2.375	0.339	1.656	0.95	0.264	1.815	0.77	0.216	1.917	0.64	0.176	2.002	0.53	2"
3"	3.500	0.500	2.440	2.06	0.389	2.675	1.66	0.318	2.826	1.39	0.259	2.951	1.16	3"
4"	4.500	0.643	3.137	3.40	0.500	3.440	2.75	0.409	3.633	2.31	0.333	3.794	1.92	4"
6"	6.625	0.946	4.619	7.37	0.736	5.065	5.96	0.602	5.349	5.00	0.491	5.584	4.15	6"
8"	8.625	1.232	6.013	12.50	0.958	6.594	10.11	0.784	6.963	8.47	0.639	7.270	7.04	8"
10"	10.750	1.536	7.494	19.42	1.194	8.219	15.70	0.977	8.679	13.16	0.796	9.062	10.93	10"
12"	12.750	1.821	8.889	27.31	1.417	9.746	22.08	1.159	10.293	18.51	0.944	10.749	15.38	12"
14"	14.000	2.000	9.760	32.93	1.556	10.701	26.63	1.273	11.301	22.32	1.037	11.802	18.54	14"
16"	16.000	2.286	11.154	43.01	1.778	12.231	34.78	1.455	12.915	29.15	1.185	13.488	24.22	16"
18"	18.000	2.571	12.549	54.43	2.000	13.760	44.02	1.636	14.532	36.89	1.333	15.174	30.65	18"
20"	20.000	2.857	13.943	67.20	2.222	15.289	54.34	1.818	16.146	45.54	1.481	16.860	37.84	20"
22"	22.000	3.143	15.337	81.32	2.444	16.819	65.75	2.000	17.760	55.10	1.630	18.544	45.79	22"
24"	24.000	3.429	16.731	96.77	2.667	18.346	78.25	2.182	19.374	65.58	1.778	20.231	54.49	24"
26"	26.000				2.889	19.875	91.84	2.364	20.988	76.96	1.926	21.917	63.95	26"
28"	28.000				3.111	21.405	106.51	2.545	22.605	89.26	2.074	23.603	74.17	28"
30"	30.000				3.333	22.934	122.27	2.727	24.219	102.47	2.222	25.289	85.14	30"
32"	32.000				3.556	24.462	139.12	2.909	25.833	116.58	2.370	26.976	96.87	32"
34"	34.000				3.778	25.991	157.05	3.091	27.447	131.61	2.519	28.660	109.36	34"
36"	36.000				4.000	27.520	176.07	3.273	29.061	147.55	2.667	30.346	122.60	36"
42"	42.000							3.818	33.906	200.84	3.111	35.405	166.88	42"
48"	48.000													48"
54"	54.000													54"

This size and dimension chart is intended for reference purposes. It should not be used in place of the advice from a licensed Professional Engineer. Pipe weights are calculated in accordance with PPI TR-7. Average inside diameter is calculated using IPS OD and Minimum wall plus 6% for use in estimating fluid flows. Actual ID will vary. When designing components to fit the pipe ID, refer to pipe dimension and tolerances in the applicable pipe manufacturing specification.

Table 7 - *Typical Sizes and Dimensions HDPE*

CaldwellMarine INTERNATIONAL
A JAG COMPANY

High Density Polyethylene

TYPICAL PROPERTIES

HDPE CHARACTERISTICS
TYPICAL PROPERTIES
CHEMICAL RESISTANCE CHART
SIZE AND DIMENSION CHARTS BY APPLICATION
CALCULATION PROGRAMS

HIGH DENSITY POLYETHYLENE PIPE
Typical Physical Properties***

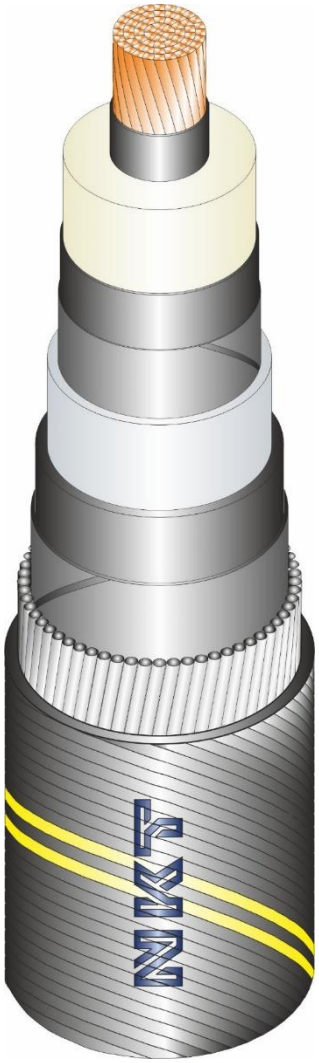
Property	Specification	Unit	Nominal Value
Material Designation	PPI / ASTM		PE 3408
Material Classification	ASTM D-1248		III C 5 P34
Cell Classification	ASTM D3350-99		345464C
-Density (3)	ASTM D-1505	gm/cm3	0.955
-Melt Index (4)	ASTM D-1238 (216 kg/190iC)	gm/10 min.	0.11*
-Flex Modulus (5)	ASTM D-790	psi	135,000
-Tensile Strength (4)	ASTM D-638	psi	3,200
PENT (6)	ASTM F-1473	Hours	>100
-HDB @73i F (4)	ASTM D-2837	psi	1,600
-HDB @ 140 Deg F	ASTM D-2837	psi	800
-U-V Stabilizer (C)	ASTM D-1603	% C	2.5
Hardness	ASTM D-2240	Shore "D"	65
Compressive Strength (yield)	ASTM D-695	psi	1,600
Tensile Strength @ Yield (Type IV Spec.)	ASTM D-638 (2"/min.)	psi	3,200
Elongation @ Yield	ASTM D-638	%, minimum	8
Tensile Strength @ Break (Type IV Spec.)	ASTM D-638	psi	5,000
Elongation @ Break	ASTM D-638	%, minimum	750
Modulus of Elasticity	ASTM D-638	psi	130,000
PENT (6)	ASTM F-1473	Hours	>100
(Cond. A, B, C: Mold. Slab)	ASTM D-1693	Fo, Hours	>5,000
(Compressed Ring - pipe)	ASTM F-1248	Fo, Hours	>3,500
Slow Crack Growth	Battelle Method	Days to Failure	>64
Impact Strength (IZOD) (.125Ó Thick)	ASTM D-256 (Method A)	In-lb / in notch	42
Linear Thermal Expansion Coef.	ASTM D-696	in / in/iF	1.2x10-4
Thermal Conductivity	ASTM D-177	BTU-in/ft2/ hrs/ degreesF	2.7
Brittleness Temp.	ASTM D-746	degrees F	< -180
Vicat Soft. Temp.	ASTM D-1525	degrees F	257
Heat Fusion Cond.	ASTM D-1525	@ psi degrees F	75 @ 400

*** This list of typical physical properties is intended for basic characterization of the material

Table 8-*Typical Properties HDPE (ISCO Industries)*

Appendix C– Submarine Cable Technical Specifications

Submarine Cable Design Sheet – 1,250 MW



DC Voltage	±400 kV	
Conductor	Profiled wires	
Type / material	Copper, Compound Water-Blocked	
Cross-section	4935 kcmil	2500 mm2
Water blocking	compound	
Diameter	2.28 in	57.8 mm
Conductor binder		
Material	semi-conductive swelling tape	
Thickness	22 mils	0.6 mm
Conductor shield		
Material	semi-conductive polymer	
Thickness	59 mils	1.5 mm
Insulation		
Material	cross-linked DC polymer	
Thickness	839 mils	21.3 mm
Insulation shield		
Material	semi-conductive polymer	
Thickness	55 mils	1.4 mm
Longitudinal water barrier		
Material	semi-conducting swell-able tape	
Thickness	26 mils	0.7 mm
Metallic sheath		
Type / material	extruded / lead alloy	
Thickness	118 mils	3 mm
Inner sheath		
Material	high-density polyethylene	
Thickness	98 mils	2.5 mm
Tensile armour		
Type / material	wire / steel	
Thickness	197 mils	5 mm
Outer serving		
Material	polypropylene yarn, 2 layers	
Thickness	157 mils	4 mm
Complete cable		
Diameter	5.44 inches	138.1 mm
Weight in air	36.4 lbf./ft.	54.2 kg/m
Weight in water	26.9 lbf./ft.	40.1 kg/m

Note: All data shall be considered nominal

Electrical Cable Properties

The submarine cable has the following electrical properties:

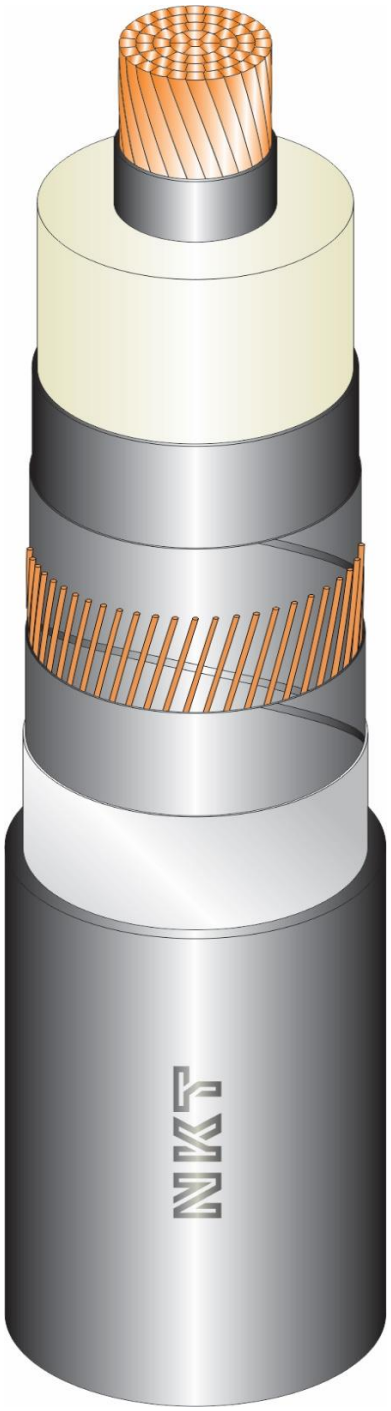
Rated continuous DC voltage, U_0	400 kV
Switching impulse withstand level (SIWL) started from U_0	900 kV
Subtractive SIWL started from U_0 to voltage at opposite polarity	400 kV
Rated continuous current under the installation conditions	1,638 A
Maximum conductor temperature in normal operation	70 °C
DC resistance at 20 °C	0.0022 ohm/1,000 ft. (0.0072 ohm/km)
DC resistance at maximum conductor temperature	0.0026 ohm/1,000 ft. (0.0086 ohm/km)
Losses at rated current	7.6 W/ft. and cable (25.0 W/m)
Capacitance	0.081 μF/1,000 ft. (0.265 μF/km)
Inductance (between conductor and metallic sheath)	0.040 mH/1,000 ft. (0.132 mH/km)
Surge impedance	22.3 ohm

CaldwellMarine INTERNATIONAL
A JAG COMPANY

Mechanical Cable Properties

Maximum Water Depth	400 feet (121.92 m)
Minimum bending radius	
- at laying (tension less than or equal 20 kN)	5.9 feet (1.8 m)
- at handling (tension greater than 20 kN)	6.9 feet (2.1 m)
- installed	5.9 feet (1.8 m)
Minimum bending radius for Chute	13.8 feet (4.2 m)
Minimum bending radius for turntable	6.9 feet (2.1 m)
Minimum coiling diameter 200 meters away from factory flexible joint	83 feet (25.3 m)
Minimum coiling diameter within 200 meters of a factory flexible joint	83 feet (25.3 m)
Maximum pulling force in conductor	
Straight Pull with conductor weld	54853lbs. (244kN)
Max permissible tension during bending MBR = 4.2 meters	47210lbs. (210kN)
Maximum side wall pressure $SWP = \frac{PullingForce}{BendingRadius}$	11240 lbs./ft. (50kN/m)

Land Cable Design Sheet – 1,250 MW



DC Voltage	±400 kV	
Conductor		
Type	Profiled Wire	
Material	Cu, Water-Blocked	
Cross-Section	4935 kcmil	2500 mm2
Diameter	2.28 in	57.8 mm
Conductor Shield/Screen		
Material	Semiconducting PE	
Thickness	59 mils	1.5 mm
Insulation		
Type	Triple Extruded, Dry Cured	
Material	XLPE	
Thickness	839 mils	21.3 mm
Diameter	4.11 in	104.5 mm
Insulation Shield/Screen		
Material	Semiconducting PE	
Thickness	55 mils	1.4 mm
Diameter	4.22 in	107.3 mm
Metallic Shield/Sheath		
Material	Semiconducting Swelling Tape	
Thickness	51 mils	1.3 mm
Type	Round Concentric Wires	
Material	Copper	
Cross-Section	150 kcmil	75 mm2
Longitudinal Moisture Barrier		
Material	Semiconducting Swelling Tape	
Thickness	53 mils	1.35 mm
Radial Moisture Barrier		
Material	Al-laminate	
Thickness	8 mils	0.2 mm
Jacket/Outer Sheath		
Material	HDPE	
Thickness	197 mils	4.8 mm
Conductive Layer	8 mils	.2 mm
Complete Cable		
Diameter	4.94 in	125.6 mm
Weight	20.9 lbs/ft	31.4 kg/m

All values should be considered indicative!

CaldwellMarine INTERNATIONAL
A JAG COMPANY

Electrical Cable Properties

The land cable has the following electrical properties:

Rated continuous DC voltage, U_0	400 kV
Switching impulse withstand level (SIWL) started from U_0	900 kV
Subtractive SIWL started from U_0 to voltage at opposite polarity	400 kV
Rated continuous current under the installation conditions.	1,638 A
Maximum conductor temperature in normal operation	70 °C
DC resistance at 20 °C	0.0022 ohm/1,000 ft. (0.0072 ohm/km)
DC resistance at maximum conductor temperature	0.0026 ohm/1,000 ft. (0.0086 ohm/km)
Losses at rated current	7.6 W/ft. per cable (25.0 W/m)
Capacitance	0.081 μF/1,000 ft. (0.27 μF/km)
Inductance (between conductor and metallic screen)	0.040 mH/1,000 ft. (0.131 mH/km)
Surge impedance	22.2 ohm

Land Cable Mechanical Cable Properties

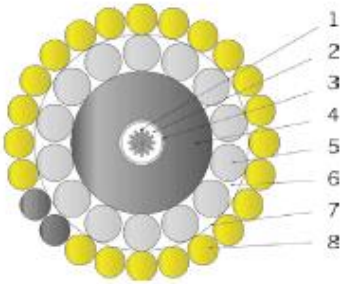
Weight of cable - in air	≈ 20.9 lbs/ft(31.4 kg/m)
Minimum bending radius - at laying - at handling (low tension) - installed	 7.4 feet (2.27 m) 5 feet (1.51 m) 5 feet (1.51 m)
Maximum pulling force	39342 feet (175 kN)
Maximum side wall pressure[1)]	1200 lbs./ ft.(17.5 kN/m)
[1)] SWP = Pulling Force / Bending Radius	

CaldwellMarine INTERNATIONAL
A JAG COMPANY

Submarine Fiber optic cable

Design

1. Primary coated fiber ..... Silica, acrylate
2. Filling compound ..... Thixotropic compound
3. Tube ..... Stainless steel
4. Sheath ..... Polyethylene, black
5. Armoring ..... Galvanized steel wires, single layer 14 x ø3.0 mm
6. Filling compound ..... Bitumen
7. Wrapping ..... Polyester tape
8. Wrapping ..... Polypropylene yarns or HDPE sheath



Typical Data

Temperature range

Operation ..... -30 till +60°C
Storage ..... -40 till +70°C
Installation ..... -15 till +40°C

Maximum water depths

..... 3000 m

Bend radius

No tensile load ..... ≥ 0.5 m
With tensile load ..... ≥ 1.5 m
Coiling ..... ≥ 1.5 m

Dimensions

Diameter ..... 22 mm

Weight

In air ..... 1.1 kg/m
In seawater ..... 0.8 kg/m

Tensile force

UTS ..... ≥ 130 kN
FBL ..... ≥ 130 kN
NTTS ..... 100 kN
NOTS ..... 70 kN
NPTS ..... 50 kN

Crush resistance

..... ≤ 10 kN/10 cm

Impact resistance

..... ≤ 200 J

Mechanical and environmental test in accordance with IEC 60794-1-21 and IEC 60794-1-22

Electroding conductor

Electrical resistance ..... 7 Ω/km

Appendix D– Emergency Response Plans

Fire Project: Installation of the CHPE Transmission Cable System:

Emergency: Fire on Board Floating Plant.

Overview
This Emergency Response Plan (ERP) has been developed specifically to support the Caldwell Marine International, LLC (CMI) marine operations. The purpose of this plan is to provide a precise set of procedures and protocols that will be used by CMI during a fire on board floating plant. Most fires start small and can be extinguished quickly. The crew must stay alert for smoke at all times. Keep flammable materials in the proper storage containers, maintain good housekeeping, and know the location of the on-board fire extinguishers.

Organization	Phone Number	Alternate
US Coast Guard	212-668-7000	VHF channel 16
Fire Department	911	
Ambulance	911	
Corporate Safety Director Lucky Abernathy	732-557-6100	908-433-3755 cell

Procedure

1. Alert the rest of the crew to the fact that there is smoke and or fire.
    a. Location of fire
    b. Type of fire A, B,C,
    c. Size of fire
    d. Source of fire
2. The barge superintendent/vessel master will quickly muster the crew, get a head count, and then provide help to the first responder.
3. Locate the nearest fire extinguisher and attempt to put out the fire.
4. Establish communications with local rescue agency (if necessary).
5. If the fire cannot be contained the barge superintendent/vessel master will evacuate the crew to safety.

After Action Report

Provide the Caldwell Marine International with a detailed chronological situation report ASAP. The formal report must be to the Health and Safety Officer within 24 hours of the incident, no exceptions.

Make a full detailed entry of the incident and all actions taken in the Daily Logs. (It is impossible to provide too much detail.)

Interview all crew and have them prepare and sign witnessed statements attesting to or denying knowledge of particulars of incident.

Emergency Response Plan - Injury

Project: Installation of the CHPE Transmission Cable System:

Emergency: Crewmember Injury

Overview

This Emergency Response Plan (ERP) has been developed specifically to support the Caldwell Marine International, LLC (CMI) marine operations. The purpose of this plan is to provide a precise set of procedures and protocols that will be used by CMI during an injury of a crewmember.

Organization	Phone Number	Alternate
US Coast Guard	212-668-7000	VHF channel 16
Fire Department	911	
Ambulance	911	
Corporate Safety Director Lucky Abernathy	732-557-6100	908-433-3755 cell

Procedure

First Responder provide First Aid to the victim and notify the barge Superintendent. When the superintendent is notified of an injury of a crewmember IMMEDIATELY:

- Begin chronological documentation.
- Log head count.
- Contact local rescue agency (If necessary).
- Start arranging for transportation to the dock. (If necessary)
- **Monitor stages of patients' condition and update the local rescue agency and Caldwell Marine International if they have been notified.**
- **Release the victim to the EMT with as much information about the accident as possible record what Hospital the victim is taken to.**

After Action Report

Provide the Caldwell Marine International with a detailed chronological situation report ASAP. The formal report must be to the Health and Safety Officer within 24 hours of the incident, no exceptions. Ensure the report includes not only how the incident occurred, but also "WHAT WAS DONE FOR THE CREWMAN AND HIS RESPONSES TO ATTEMPTED TREATMENT"

Make a full detailed entry of the incident and all actions taken in the Daily Logs. (It is impossible to provide too much detail)

Interview all crew who knew where the crewman was at the time of injury and have them prepare and sign witnessed statements attesting to or denying knowledge of:

- What the crewman was doing and any statements he made before, during, and after the incident.
- What took place around and for the crewman before, during and after the incident.
- What safety gear the person was or was not wearing.
- Did the witness believe the person knew he was in a hazardous situation and why did the incident occur.
- Were all available preventable measures attempted by the crewman before the incident occurred?

Emergency Response Plan – Man Overboard

Project: Installation of the CHPE Transmission Cable System:

Emergency: Man Overboard

Overview

This Emergency Response Plan (ERP) has been developed specifically to support the Caldwell Marine International, LLC (CMI) marine operations. The purpose of this plan is to provide a precise set of procedures and protocols that will be used by CMI during a Man Overboard Incident.

Organization	Phone Number	Alternate
US Coast Guard	212-668-7000	VHF channel 16
Fire Department	911	
Ambulance	911	
Corporate Safety Director Lucky Abernathy	732-557-6100	908-433-3755 cell

Procedure

IF A PERSON IS WITNESSED FALLING OVER THE SIDE:

Spotter notifies barge superintendent of the incident immediately by any means so as not to lose sight of victim. Spotter designated and has visual contact of person in water and has no other assigned task that would require him to ever lose visual contact.

If the barge is spud down or the vessel anchored, and the victim is able to help themselves back to the vessel assist them in the up and over process.

If underway turn stern hard over away from the side the person fell over.
Flotation devices and light markers thrown overboard.
Begin a written chronological record of the event. Record latitude and longitude

If victim does not give the "OK" signal, begin establishing communications with the nearest rescue facility to standby for medical evacuation.

Rescue Crew:

Complete a head count of all personnel aboard. (Ensure only one person missing.)

Rescue boat and boat crew rigged and ready to launch.

One member of rescue boat crew outfitted as rescue swimmer, rigged with retrieval harness and retrieval line.

Medical equipment standing by ready to treat for hypothermia and/or possible blunt trauma from the fall.

Utilize rescue swimmer to bring victim to ladder mounted on beam.

No matter the rescued victim's verbal description of his/her medical condition, perform primary and secondary medical survey.

Update the rescue facility it they were initially called. If they are already enroute to your position, have them continue to take the person to a medical facility.

Provide the Caldwell Marine International with a detailed chronological situation report ASAP. The formal report must be to the companies Health and Safety Officer within 24 hours of the incident, no exceptions.

IF PERSON IS ASSUMED MISSING OVERBOARD:

Immediately establish contact with, and provide detailed chronological situation report with the nearest search and rescue agency.
Begin search as advised by assisting rescue agency.
Call for any vessels in the vicinity to assist in search if willing. Determine water temperature, water current direction and speed.
Interview crew under witness, have them prepare and signed witnessed statements attesting to or denying knowledge of following:

- Last area person was seen.
- Last time the person was seen.
- What the person was wearing.
- Any preexisting medical or mental condition.
- What task the person was last assigned to.
- His/her perceived mental state.

Provide the Caldwell Marine International with a detailed chronological situation report ASAP. The formal report must be to the companies Health and Safety Officer within 24 hours of the incident, no exceptions.

Appendix E– Spill Prevention Plan/Spill Response Plan

RESERVED – Please reference Appendix I of the main document – HDD SWPP

CaldwellMarine INTERNATIONAL
A JAG COMPANY

Appendix F – Drilling Fluid Containment Plan and Erosion/Mud Control Plan

INADVERTENT RETURN AND CONTAINMENT OF BENTONITE DRILLING FLUIDS MATERIALS

In the HDD industry, the ability to respond and handle inadvertent returns must be a part of the construction procedures. Huxted Trenchless, LLC (HT) is experienced and completely prepared for their responsibility regarding eliminating or reducing the possibility of an inadvertent return to surface.

ALL DRILLING OPERATIONS WILL BE SUSPENDED IF DRILLING FLUIDS POSE A THREAT TO THE RESOURCE OR PUBLIC HEALTH AND SAFETY. Huxted Trenchless' s standard procedure for containment of an inadvertent return of bentonite drilling fluids during drilling operations:

Cease drilling operations immediately

- Notify Site Inspector, NYSDEC and additional permitting agencies
- Contain any surface release
- Place pump or vacuum equipment
- Document (within 48 hours a report will be provided to the NYSDEC)
- Review options with on-site inspectors
- Implement procedures
- Resume drilling

During drilling operations should HT experience partial loss of mud returns, or a visible inadvertent return is encountered, HT will immediately cease pumping of drilling fluids and commence placing containment barriers around the release. If necessary, pumps or vacuum trucks will be positioned at the location for transfer of mud back to the recycling system or to a pre-approved disposal site. During this operation the client's site inspector, NYSDEC or engineer will be notified and consulted to ensure the removal will not cause additional adverse impacts to the natural resources. The drilling superintendent will then provide all necessary documentation as to time, location, pump and bit pressures and estimated volumes of the inadvertent return to the proper authorities. Once contained, HT will review the situation and provide all options to the client for approval. (See attached Inadvertent Return report)

Equipment and hand tools will be present on site to assist in any clean-up that might be necessary. Vac-trailers and pumps will be on site along with various hand tools (ie. Shovels, rakes, brooms, silt fence and hay bales.

In the event of an inadvertent return to the lake or river, the stand-by dive team will immediately be called on to assist in the cleanup effort. For small quantities of drill fluid released the divers will remove the material with hydraulic pumps. For a larger release in water, an additional gravity cell will be installed over the disturbed area to contain the release from spreading. The cleanup effort will include recovering the drilling fluid to the surface containment tanks and where it will be stored until it is disposed of at an approved location. The area disturbed by the release and subsequent clean-up will be restored to preexisting condition to the extent possible.

Along with our standard inadvertent return procedures, other methods can be implemented to avoid or reduce a surface release. The design of the crossing should be reviewed for sufficient depths in various soil and rock conditions. In addition, some loss circulation materials (LCM) and special drilling techniques can provide the contractor some assistance in reducing inadvertent returns and or loss circulation down hole.

HT considers any inadvertent return as priority and will ensure that there are protective measures in place to contain or quickly recover any bentonite drilling fluids that may migrate to the surface. In addition, HT will make every effort during the drilling operations to prevent the possibility of a release. However, when drilling in subsurface conditions with limited geotechnical data, no drilling contractor can guarantee that inadvertent returns will not occur.

Inadvertent Return Report

Report # _____

Date: _____ Huxted Job#: _____

Time: _____ Client: _____

IR Location

Project Station: _____ Landmark: _____

Offset: _____ Estimated Volume: _____

GPS: _____ Estimated Volume: _____

Drill Bit Location

Project Station: _____ Landmark: _____

Elevation: _____ Pump Rate: _____

Depth: _____ Formation: _____

Contacts

CMI – Tom Ulisse, Project Executive
732-620-3470

NKT – Fredrik Hallsten
919-836-3522

NYSDEC – 1-800-457-7362

Description

_____

_____

_____

_____

_____

Mitigation

_____

_____

_____

_____

_____

Table 9 – Inadvertent Return Report

Erosion & Mud Control Plan

1.0 Erosion Control

Prior to drilling operations, HT will implement erosion control procedures and containment for disposal of rainwater, drilling fluids and alluvial soils.

1.1 Erosion Control

On the operations site, earthen berms are constructed for containment and flow direction of any fluids back to the containment pit which is located in front of the drilling rig. Silt fencing is installed around all possible contamination areas. The containment pit is approximately 6 foot wide, 6 foot long and 4 foot deep. This fluid can be pumped back to the mud system for recycling down hole.

If excessive amounts of rainwater are encountered, hay bales, straw and silt fencing can be placed on or around the erosion site to provide some stabilization of the ground. Should heavy runoffs occur, a deflection or containment berm or shallow pit can be constructed, and any fluids pumped back to holding tanks or our mud system.

Should drilling fluids create any erosion along the drill path, HT will cease pumping drilling fluid down hole and notify our client for immediate consultation.

1.2 Disposal of Materials

Prior to commencement of drilling operations, an HT superintendent will arrive on site to meet with our client, contact vendors and establish a method for transportation and disposal of drilling fluids and cuttings. In addition, vacuum trucks and holding tanks are identified which can be put on notice for containment and disposal assistance.

2.0 Drilling Mud

2.1 Introduction

The following paragraphs describe the drilling fluid handling and containment procedures typically practiced by HT. These procedures have been implemented to minimize the potential for environmental disturbance during the directional drilling process.

The drilling fluid is an essential element of any directionally drilled pipeline installation.

Amongst other benefits, the fluid serves many purposes including:

- Removal of the drilled cuttings from the borehole.
- Maintaining the integrity of the borehole.

- Lubricating and cooling the drill bit.

The drilling fluid typically used by HT in completing directionally drilled installations is a naturally occurring non-toxic, colloidal clay called sodium montmorillonite, or bentonite that is mined principally in Wyoming. Bentonite swells in water by absorbing the water, thus providing a viscous fluid to carry cuttings. The desired viscosity of the non-toxic bentonite fluid will vary with differing formations. By monitoring the mud, the HDD contractor can determine the correct properties needed for drilling in the different types of formations, i.e. maximum cleaning, loss circulation and inadvertent return control.

2.2 Drilling Mud Standards

Two concerns develop from the use of drilling fluids at a given location. These are the handling of the fluid on-site and the disposal of the excess fluid at the completion of the job. Both of these concerns are simplified if the products entering the mud system are of a non-toxic nature.

To ensure that the drilling fluid meets the required disposal and environmental standards, HT adopts the following guidelines:

- HT identifies in advance of drilling, the proposed drilling fluid products and the local water source to be used.
- HT will not add any other products to the mud system without prior approval.
- Under no circumstances will HT use petroleum-based products.
- HT ensures that petroleum products such as hydraulic oil, used oil or fuel will not migrate into the mud fluid system.
- HT produces and maintains daily reports showing the amount and type of products used.
- HT tests the drilling fluid on a regular basis to identify the mud properties such as, viscosity, water content, gel strength, solids content, hydrogen ion content (P.H.)
- HT purchases all mud products from a reputable supplier who will supply Material Safety Data Information that adheres to all regulations and assures the products are non-toxic.

The Material Safety Data Sheets will further describe these products.

2.3 Drilling Fluid Handling Equipment and Containment

HT utilizes a **closed loop** drilling fluid system whereby the fluid exiting the borehole is cleaned and re-circulated. The **closed loop** system offers a number of advantages including reducing the amount of fluid that must be made up to complete a project and reducing the amount of fluid to be disposed of upon conclusion of the pipeline pull-through.

A typical **closed loop** system begins with drilling fluid being prepared to desired viscosity and stored in a mud mixing tank. The fluid is then pumped, via mud pumps, at desired pressure and flow to the drill rig and down the drill pipe. The mud pumps are controlled either by the driller from the operations cab at the rig or from the mud mixing tank.

The mud is pumped down the drill string, through the downhole motor, if employed, and then released through the nozzles of the bit or jet. The fluid then returns along the annulus between the borehole and drill string carrying, in suspension, the drilled cuttings. The fluid then flows into a sump prepared at surface at the borehole entry point. From this sump, the fluid is pumped to desanders and shakers where the drilled cuttings are removed. The cuttings are contained within metal roll-off dumpsters alongside the cleaning unit and transported to an approved disposal site. The size and particulars of the desanders and shakers will be subject to the particulars of the project. Following removal of the drilled cuttings, the clean fluid is pumped to the mud storage tank to be re-used.

HT does not believe any additional procedures, other than prudent operating practices, will be necessary for the control of drilling fluids at the entry locations. The drilling fluid will be contained at all times within surface tanks and sumps. Consequently, there should not be any drilling fluid elsewhere on the location.

The drilling fluid hoses, transfer lines and pumps will be carefully laid out and regularly inspected to avoid any failures and inadvertent release of fluid. The mud tanks and cleaning units will be of appropriate sizes to ensure adequate capacities. Cuttings will be contained within on-site metal roll-off containers. Through careful planning and attentive operations, HT is able to maintain a clean and environmentally responsible working area.

2.4 Drilling Mud Disposal

Prior to commencement of drilling operations, the drilling superintendent will establish a landfill or off-site facility for disposal of all excess drilling fluids and cuttings.

Solids Disposal

During the pilot hole and reaming operations, bentonite drill fluids will carry the solids from the formation back to the entry pit. The fluids and cuttings will be pumped back to the recycling system for separation and containment. The solid materials (maximum of 50% water by volume) will be placed in a metal roll-off dumpster and prepared for hauling to an approved site.

Bentonite Disposal

The bentonite drilling fluids are continually being cleaned and recycled back down hole to reduce drilling costs. If multiple drills are planned at the same location or in close proximity, the bentonite will be either stored or transported to the next site. After the project is completed, the drilling fluids will be sucked up in a vacuum truck to be transported to the approved site for disposal.

The vendor that supplied the roll-off containers is equipped with special haul trucks for loading and unloading of the containers. Unless other arrangements are made, HT will contract the vendor to supply and haul solid materials and remaining drilling fluids to the disposal site.

3.0 Avoiding Environmentally Sensitive Areas

The most appropriate method to avoid fluid migration to environmentally sensitive areas is through careful design of the borehole profile, careful attention to drilling progress and fluid pressures, and through environmentally responsible working practices.

HT endeavors to avoid drilling fluid migration by designing an appropriate borehole profile well removed from the sensitive area and maintaining fluid pressures within acceptable limits while drilling the initial portion of the pilot hole.

4.0 Environmental Responsibility

HT will also implement procedures to minimize the potential for environmental disruption within other areas of the project. These areas include site preparation, site restoration, and attentive material handling/storage of fuels, including noise abatement. The following paragraphs further describe procedures which may be implemented to limit environmental disruption in these areas.

4.1 Site Preparation/Site Restoration

The layout of equipment and materials at the entry and exit locations must be carefully prepared to limit the required working area. In this way, the amount of site preparation and the resulting environmental disturbance can be minimized. Spill kits will be present on-site during drilling activities. These kits will contain at a minimum, absorbent pads and socks, disposable bags, gloves, safety glasses, etc. With the proposed crossing, it is likely that certain site preparations will be required at the proposed entry and exit locations. Further site restorations will be performed as required.

4.2 Containment and Disposal of Fuels and Other Materials

HT has reviewed the potentially hazardous materials that may be on-site. The oil-based products to be used on-site consist of:

* Diesel fuel
* Gasoline
* Lube Oil Products
* Bearing Grease
* Pipe Lubricant
* Hydraulic Oil
* Used Oil Products
* Garbage
* Used Filters, Rags etc.

There will not be more than 500 gallons of diesel fuel nor more than 50 gallons of hydraulic fluid on site at any given time. Therefore, the Petroleum Bulk Storage (PBS) and Chemical Bulk Storage (CBS) requirements are deemed not applicable.

Diesel Fuel

Required to fuel drill rig motor and heaters, will be transported by approved bulk trucks. To ensure spillage does not occur, all engines are connected

to one fuel supply with approved hoses or steel lines. Limited amounts of fuel will be stored on-site. Refueling operations will not be permitted any closer to water courses than the entry location.

Gasoline

Will be required for remote water pump engines, including other support pumps and/or generators. This will be supplied and transported in barrels or other approved containers. The transfer of gas from barrels to the engines will be carried out with barrel pumps that fit solidly into the barrel opening.

Lube Oil

Will be required for all engines to maintain oil levels and oil changes. Oil will be supplied in approved containers or cans, in case lots, or pails. This reduces the chance of sizable spills and makes handling easier. Used oil will be caught in containers designed to fit below the drain opening. The used oil will then be placed in a barrel which can be sealed. The contained used oil will be removed from the site at the end of the project and disposed of in an approved manner.

Bearing Grease

This will be required in very limited amounts. The packaging of the product will be in container tubes which are placed directly into the grease guns.

Pipe Thread Lubricant

Required for the lubrication of the drill string connections to eliminate thread galling and excessive joint tightening. As any excessive lubricant on the drill string threads can be washed into the water, HT recommends the use of a lubrication that is comprised of a bentonite-based material and other non-toxic material. This lubricant is used extensively on water well drilling or other areas where foreign substances of a toxic nature cannot be allowed to mix with the local water sources.

Hydraulic Oil

Will be required on a limited basis for the drill rigs hydraulic system. This system is used for drill pipe rotation, pull and push capacity and the break-out or make-up of drill pipe. Again, limited quantities will be required and will be transported in sealed containers or barrels. The initial filling of the rigs reservoirs will be required on-site once the rig is assembled. Filling will only be required in the remote event that a leak develops.

HT will ensure that there are protective measures in place to contain or quickly recover any oil that may leak from the units by ensuring that all hydraulic hoses and fittings are in good shape and designed for cold weather applications. All hydraulic pump bearing seals will be checked for leaks and repaired as necessary.

Absorbent oil spill padding will be on-site and will be placed under areas of the drill rig where the possibility of an oil leak might occur. This will absorb any oil that may escape before the leak is discovered and repairs can be made.

Used Oil

The handling and containment of used oil is always a potential problem at any temporary work site. In this case the short duration required for each drill will reduce to a very minimum, the volume of used oil. However, even in this case, used oil will accumulate throughout the project and must be accommodated.

HT will provide sufficient containers on-site to hold all used oil accumulated. These containers will have openings that can be sealed shut when full. This will allow them to be transported without any possibility of leaking enroute.

Used oil should be taken to a proper treatment plant where it can be disposed of in an approved manner.

Garbage

Any construction or drilling site will accumulate a reasonable amount of garbage that requires disposal. HT will collect all garbage of a non-toxic nature in approved dumpsters that will be supplied by and removed by an authorized collection company within the general area.

Used Filters, Oily Rags of a Toxic Nature

To transport this material safely, HT recommends containers that can be sealed against leakage once they are filled. These containers will be identified by clearly marking on the barrel, the nature of the contents within. Once filled, they will be taken to an approved licensed disposal area.

The handling of waste during this project will adhere to all applicable regulations.

5.0 Responsibility for Reporting & Responding to Spills

In undertaking a directional drilled pipeline installation, the ability to respond and handle spills is an important part of the work procedures. HT is fully knowledgeable of our responsibility in ensuring that spills do not occur. However, should a spill occur, the impact must be limited by rapid containment of the product, by minimizing the amounts of fluid on-site, by ensuring the availability of clean-up products/equipment on-site to immediately contain, control, and clean-up the spill and by notifying immediately the proper authorities.

The quantity of fluid on a directional drilling site shall be kept to a minimum. Fuels and lubricants are contained in appropriate containers that reduce any single quantity to minimal amounts. Diesel fuel tanks are part of the equipment housing module and could amount to two or three separate tanks, again reducing the quantity in any one container. Lube oils are delivered to the sites in their marked containers, which might be barrels, pails, or cans.

Drilling fluids on surface, although not of a toxic nature, cannot be ignored if a spill occurs. The containment surface equipment consists of steel tanks that are divided into three or more compartments. These mud containment tanks are part of the total enclosed re-circulating drilling fluid process, which is used successfully on drilling rigs worldwide without major spills occurring.

An excavated containment pit is dug directly adjacent to the drilling fluid surface tanks. This pit is designed to catch all drilled cuttings, desander overflows and whatever drilling fluid that adheres to the solid particles.

Both the entry and exit sites will have shovels, pickaxes, containers, and absorbent materials available that will immediately be put to the task of containing and recovering any fluids that might escape from the equipment or storage containers.

The entire drill crew will be aware of their responsibility to maintain a spill free environment. The crew will also be aware of the required response should a spill occur. The crew will have responsibility to report spills of any size to their immediate supervisor, who in turn will advise the Client.

Appendix G– Non-Conformance Report

Caldwell Marine International	CHPE SUBMARINE CABLE INSTALLATION NON-CONFORMANCE (NC) CORRECTIVE ACTION AND CLEARANCE REPORT (NCR)	Project: CHPE Location:Ny, Job #

NC Report No:		Date:	
Location:			
Project phase:			

PART 1: DESCRIPTION OF NON-CONFORMANCE				
NC Importance		Major Minor	Relevant requirement:	
Signature - NKT representative:				Date:
Name/Title - NKT representative:				
Signature - CMI representative:				Date:
Name/Title - CMI representative:				

PART 2: PROPOSED CORRECTIVE ACTION

PART 3: COMPLETED CORRECTIVE ACTION

PART 4: CORRECTIVE ACTION VERIFIED AND CLEARED	
Signature - NKT representative:	Date:
Name/Title - NKT representative:	
Signature - CMI representative:	Date:
Name/Title - CMI representative:	

Appendix H– Equipment Calibration Documentation

Equipment calibration of gyroscope documentation to be submitted upon completion of calibration operations.

Appendix I– Inspection and Test Plans

Material Inspection

Caldwell Marine International 1333 Campus Parkway Wall Township, NJ 07727 732-557-6100	**CHPE SUBMARINE CABLE INSTALLATION INSPECTION & TEST PLAN**	Project: CHPE Location: NY Job # 1229
	HDD Shore Crossings	Prime: NKT Inc.

SEGMENT: **LOCATION:**

Material/Parameter to be Controlled/Checked	Control Method/Equipment	Control Frequency	QC By	Reference Document	QA Record	For External Use						
						R/W/H		Code				
						Int	Ext	A	B	C	D	E
HDPE Pipe	Visual	Upon Delivery	PS		Daily Ops Log							
HDPE Pipe	Dimension	Upon Delivery	PS		Daily Ops Log							
HDPE Pipe	Quantity	Upon Delivery	PS		Daily Ops Log							
HDPE Pipe	Supplier Certificate	Upon Delivery	PS		Daily Ops Log							
HDPE Fusion	Visual Inspection	Prior to start of ops-each segment	PS		Daily Ops Log							
HDPE Fusion De-Beading	Visual Inspection	Post fusing of pipe	PS		Daily Ops Log							
HDPE Fusion Dat Logging	Automated Report	Post fusing of pipe	Fusing Technician		Daily Ops Log							
Verify HDD Pipe Depth for Proper Cable Burial Depth	Visual Inspection	Post Pipe Pull-In	PS		Daily Ops Log							

PM-Project Manager. PS-Project Superintendent. PE-Project Engineer. BS-Barge Superintendent. BC-Barge Captain. BM-Beach Master.

Caldwell Marine International 1333 Campus Parkway Wall Township, NJ 07727 732-557-6100	**CHPE SUBMARINE CABLE INSTALLATION INSPECTION & TEST PLAN** **HDD Shore Crossings**	Project: CHPE Location: NY Job # 1229 Prime: NKT Inc.

R: REVIEW - document and records shall be available for verification at any time by the QA representative (QAR) / Purchaser Representative (PR).
W: WITNESS - a critical step in installation or testing where it is desirable for the QAR/PR inspect the material/equipment/activity/operation in order to ascertain compliance with the project requirements. The operation may proceed without the presence of the above representatives, as long as they have been informed prior to the start of operations.
H: HOLD - a critical step in installation or testing where it is essential for the QAR/PR inspect the material/equipment/activity/operation in order to certify compliance with the project requirements. The operation may not proceed without the presence of the above representative. A HOLD point may not be waived unless this has specifically been confirmed in writing.
QA By: Indicates the designated inpsector/auditor within the manufacturer/supplier/contractor's organization responsible for the QA activity.
Int: Indicates R/W/H points internal to the Manufacturer/Supplier/Contractor.
Ext:

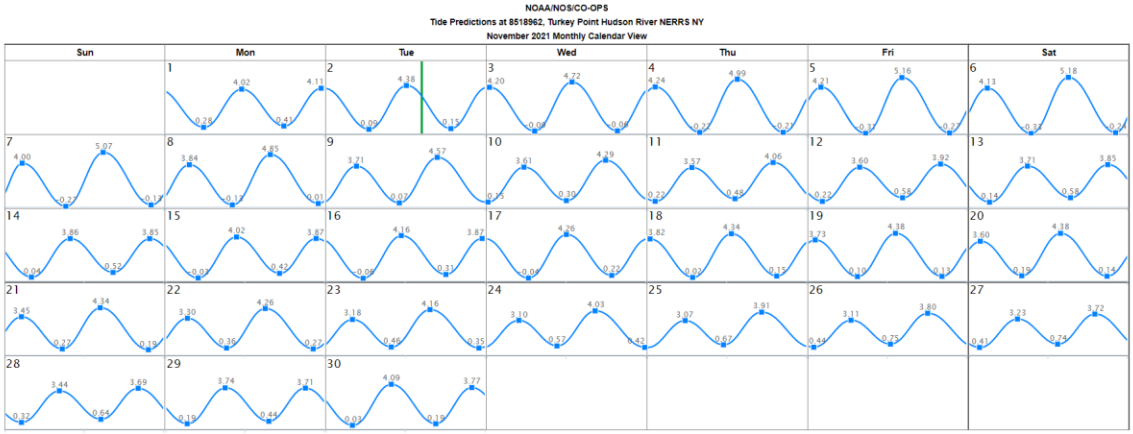
Code	Description
A	Place where task/activity is to be performed 1: At NKT Facility 2: At installation site 3: At contractor facility 4: At manufacturer/supplier facility 5: Other customer or end-client facility
C	Report required by/for 1: NKT QAR 2: BEC Design Representative 3: 3rd Party Inspector/Consultant 4: Other customer - end client's representative

Code	Description
B	Person to be present for the activity, inspection, audit, witness review, or hold point 1: NKT QAR 2: BEC Design Representative 3: 3rd Party Inspector/Consultant 4: Other customer - end client's representative 5: Hold point with no specified external witness
D	Project specific use
E	Scope for which the task/activity applies F: First piece inspection R: Random check to be detemined by the inspector S: Sample inspection, as per NKT accepted plan X: Full scope

Prepared and submitted by Caldwell Marine International.	Accepted by:	Received by:
Date:	Date:	Date:
Project Manager: Caldwell Marine Int.	QA Manager - TBD	Project Manager: NKT Inc.

Appendix J– Tidal Forecast

Typical tidal range during a full moon.



DATASHEET

TRIMBLE VX SPATIAL STATION

KEY FEATURES

Now available with **Trimble VISION** technology for video robotic control and scene documentation

Surveying, imaging and 3D scanning in **one powerful solution**

Increase your agility to **adapt to any situation**

Create enhanced 2D and 3D deliverables for rich information management

Capture and combine scanning, imaging and surveying deliverables with the singular solution designed for surveyors. Integrating the technologies of advanced optical surveying, metric imaging and 3D scanning, the Trimble® VX™ Spatial Station is the only surveying instrument that does it all and does it with ease.

CAPTURE THE SHAPE OF THE REAL WORLD – EVERY DAY

Expectations from surveying customers are evolving. To improve the efficiency of capturing advanced Spatial Imaging deliverables, Trimble provides an integrated solution for bringing these technologies together within the traditional workflows surveyors already use. So you have the flexibility to perform feature-rich scans every day, without the complexity of setting up a separate scanning system or switching to specialized field software.

With the Trimble VX Spatial Station, you can efficiently capture the information you need to create digital terrain models (DTMs), volume calculations, and perform topographic measurements faster than with traditional surveying methods.

HARNESS THE POWER OF TRIMBLE REALWORKS SOFTWARE

Advanced 3D models and image-rendered 3D surfaces are within your reach with the rich data delivered by Trimble Spatial Imaging sensors. With the ability to capture metric images with the Trimble VX in the field, you are also able to make additional measurements and attribute the data back in the office. It's all accessible to surveyors with the Trimble VX and Trimble RealWorks® software. Your clients will immediately see the detail of your work via 3D walkthroughs of the job site using your survey data, images, and scanned information all from the Trimble VX.

VIDEO-ASSISTED CONTROL

Trimble VISION™ gives you the power to see everything the instrument sees. Direct your work with live video images on the controller. Now you are free to capture measurements to prism or reflectorless surface with a point and click.

COMBINE GNSS AND OPTICAL DATA

Take your productivity even further by adopting Trimble Integrated Surveying™ workflows – simply add your GNSS receiver to your robotic rod and powerful Trimble field software will seamlessly take care of the rest. This allows you to collect GNSS and optical data while simultaneously scanning a surface or site. With the built-in imaging and 3D scanning capabilities, you can capture the shape of objects of interest, such as a nearby building or power lines while you perform your traditional survey work.

With the long range capabilities of the Trimble DR Plus EDM, you measure further with fewer instrument set-ups and enhance your scanning performance.

Trimble.

GENERAL SPECIFICATIONS

PERFORMANCE

Scanning (not enabled on all models)
- Range[1, 2] . . . from 1 m up to 250 m (3.28 ft–820 ft)
- Speed[1] . . . up to 15 points/sec, typical 5 points/sec
- Minimum point spacing . . . 10 mm (0.032 ft)
- Standard deviation . . . 3 mm @ ≤150 m (0.0098 ft @ ≤492 ft)
- Single 3D point accuracy . . . 10 mm @ ≤150 m (0.032 ft @ ≤492 ft)

Angle accuracy . . . 1" (0.3 mgon)
Sensor type . . . Absolute encoder with diametrical reading
Automatic level compensator
- Type . . . Centered dual-axis
- Accuracy . . . 0.5' (0.15 mgon)
- Range . . . ±5.4' (±100 mgon)

Other distance measurement
Accuracy (RMSE)
- Prism mode
  - Standard . . . 2 mm + 2 ppm (0.0065 ft + 2 ppm)
    - Standard deviation according to ISO17123-4 . . . 1 mm + 2 ppm (0.003 ft + 2 ppm)
  - Tracking . . . 4 mm + 2 ppm (0.013 ft + 2 ppm)
- DR mode
  - Standard . . . 2 mm + 2 ppm (0.0065 ft + 2 ppm)
  - Tracking . . . 4 mm + 2 ppm (0.013 ft + 2 ppm)

Measuring time
- Prism mode
  - Standard . . . 1.2 sec
  - Tracking . . . 0.4 sec
- DR mode
  - Standard . . . 1–5 sec
  - Tracking . . . 0.4 sec

Range
- Prism mode (under standard clear conditions[4, 5])
  - 1 prism . . . 2,500 m (8,202 ft)
  - 1 prism Long Range mode . . . 5,500 m (18,044 ft) (max. range)
  - Shortest possible range . . . 0.2 m (0.65 ft)
- DR mode

	Good (Good visibility, low ambient light)	Normal (Normal visibility, moderate sunlight, some heat shimmer)	Difficult (Haze, object in direct sunlight, turbulence)
White card (90% reflective)[2]	**1,300 m (4,265 ft)**	**1,300 m (4,265 ft)**	**1,200 m (3,937 ft)**
Gray card (18% reflective)[2]	**600 m (1,969 ft)**	**600 m (1,969 ft)**	**550 m (1,804 ft)**

  - Shortest possible range . . . 1 m (3.28 ft)
  - DR Ranges (typically)
    - Concrete . . . 600–800 m (1,968–2,624 ft)
    - Wood construction . . . 400–800 m (1,312–2,624 ft)
    - Metal construction . . . 400–500 m (1,312–1,640 ft)
    - Light rock . . . 400–600 m (1,312–1,968 ft)
    - Dark rock . . . 300–400 m (984–1,312 ft))
    - Reflective foil 20 mm . . . 1,000 m (3,280 ft)
  - Extended Range Mode
    - White Card (90% reflective)[2] . . . 2,000–2,200 m
    - Gray Card (18% reflective)[2] . . . 900–1,000 m
    - Accuracy . . . 10 mm + 2 ppm (0.033 ft + 2 ppm)

ROBOTIC OPERATION

Range[5]
- Passive prisms . . . 500–700 m (1,640–2,297 ft)
- Trimble MultiTrack Target . . . 800 m (2,625 ft)

Autolock pointing precision at 200 m (656 ft) (Standard deviation)[5]
- Passive prisms . . . <2 mm (0.007 ft)
- Trimble MultiTrack Target . . . <2 mm (0.007 ft)

Shortest search distance . . . 0.2 m (0.65 ft)
Type of radio internal/external . . . 2.4 GHz frequency-hopping, spread-sprectrum radios
Search time (typical)[6] . . . 2–10 sec

GENERAL SPECIFICATIONS

SYSTEM SPECIFICATIONS

Leveling	
Circular level in tribrach	8'/2 mm (8'/0.007 ft)
Electronic 2-axis level in the LC-display with a resolution of	0.3" (0.1 mgon)
Servo system	MagDrive servo technology, integrated servo/angle sensor electromagnetic direct drive
Rotation speed	115 degrees/sec (128 gon/sec)
Rotation time Face 1 to Face 2	2.6 sec
Positioning speed180 degrees (200 gon)	2.6 sec
Clamps and slow motions	Servo-driven, endless fine adjustment
Centering	
Centering system	Trimble 3-pin
Optical plummet	Built-in optical plummet
Magnification/shortest focusing distance	2.3×/0.5 m to infinity (1.6 ft to infinity)
Telescope	
Magnification	30×
Aperture	40 mm (1.57 in)
Field of view at 100 m (328 ft)	2.6 m at 100 m (8.5 ft at 328 ft)
Shortest focusing distance	1.5 m (4.92 ft) to infinity
Illuminated crosshair	Variable (10 steps)
Autofocus	Standard
Camera	
Chip	Color Digital Image Sensor
Resolution	2048 x 1536 pixels
Focal length	23 mm (0.07 ft)
Depth of field	3 m to infinity (9.84 ft to infinity)
Field of view	16.5° x 12.3° (18.3 gon x 13.7 gon)
Digital zoom	4-step (1x, 2x, 4x, 8x)
Exposure	Automatic
Brightness	User-definable
Contrast	User-definable
Image storage	Up to 2048 x 1536 pixels
File format	JPEG
Compression ratio	User-definable
Video streaming[7]	5 frames/sec
Operating temperature	–20 °C to +50 °C (–4 °F to +122 °F)
Dust and water proofing	IP55
Power supply	
Internal battery	Rechargeable Li-Ion battery 11.1 V, 4.4 Ah
Operating time[8]	
One internal battery	Approx. 5 hours
Three internal batteries in multi-battery adapter	Approx. 15 hours
Robotic holder with one internal battery	Approx. 12 hours
Weight	
Instrument	5.25 kg (11.57 lb)
Trimble CU controller	0.4 kg (0.88 lb)
Tribrach	0.7 kg (1.54 lb)
Internal battery	0.35 kg (0.77 lb)
Trunnion axis height	196 mm (7.71 in)
Communication	USB, Serial, Bluetooth®[9]
Security	Dual-layer password protection

EDM SPECIFICATIONS

Light source	Pulsed Laser diode 905 nm; Laser class 1
Laser pointer coaxial	Laser class 2
Beam divergence Prism mode	
Horizontal	4 cm/100 m (0.13 ft/328 ft)
Vertical	8 cm/100 m (0.13 ft/328 ft)
Beam divergence DR mode	
Horizontal	4 cm/100 m (0.13 ft/328 ft)
Vertical	8 cm/100 m (0.13 ft/328 ft)
Atmospheric correction	–130 ppm to 160 ppm continuously

Trimble.

- Leica RTK DGPS

Appendix L– Equipment Specifications

ENVIRONMENTAL CROSSINGS, INC.
RIG NO. 7

AMERICAN AUGERS DD-210 (1999)
EQUIPMENT LIST

American Auger DD-210

AMERICAN AUGERS DD-210:

RATED TO 210K PUSH AND PULL
RATED TO 30K TWO SPEED ROTARY TORQUE
3306 CAT POWERED
CONTROLS SAUER SUNSTRAND JOYSTICKS
OPEN BREAK OUT TRAVEL VISES
ROTARY BRAKES
HYDRAULIC OIL HEAT EXCHANGER
TRAILER LOW BOY (45 FT) PERMIT LOAD
HYD. 8,000 LB CAPACITY CRANE

ECI MUD SYSTEM:

ECI DESIGN AND BUILT
147 BBL CAPACITY
3406 CAT POWERED
285 KW GENERATOR
3 - 5" X 6" (50 HP) CHARGE AND MIXING PUMP
DE-SILTERS (1000 GPM)
DE-SANDERS (1000 GPM)
LINEAR THREE PANEL SHAKERS
3 - 3.5' X 7.5' SCALPER, DESANDER, DESILTER SHAKERS
200 GALLON FUEL CAPACITY
TRAILER MOUNTED (48 FT) NON PERMIT LOAD

CaldwellMarine INTERNATIONAL
A JAG COMPANY


Mud System

ECI MUD PUMP: ELLIS WILLIAMS 446 MUD PUMP (CAPACITY 460 GPM)
DROPDECK TRAILER
POWERED BY 3406 CAT
REMOTE CONTROL CONSOLE
FUEL CAPACITY 400 GAL.
MISC. MUD LINES

CONTROL UNIT: ECI. BUILT 10' FT X 8 FT CONTROL UNIT
MOUNTED SAUER SUNSTRAND DRILLER CONTROLS
STEERING EQUIPMENT

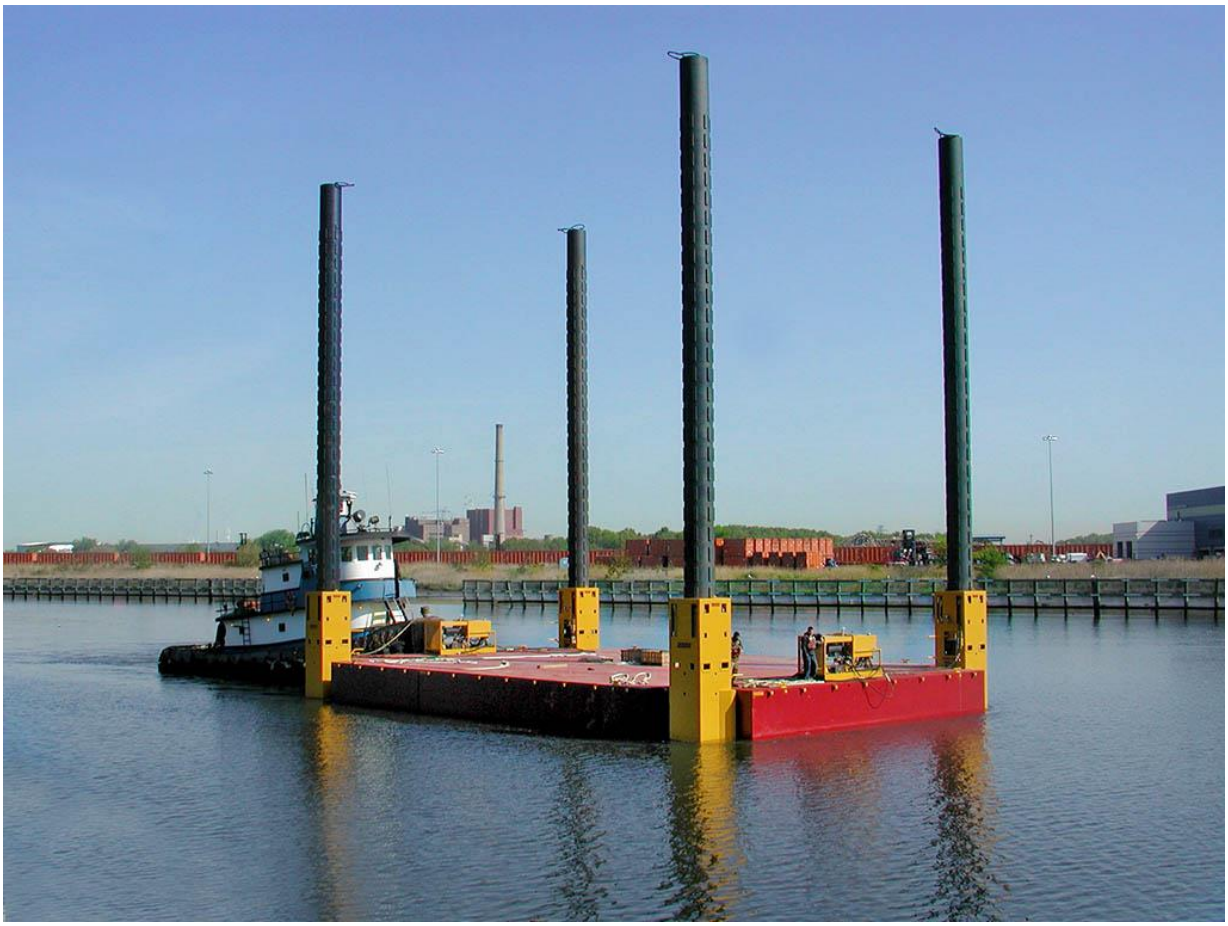
TOOL VAN: 20'X 8' CONTAINER
LUFKIN FLATBED TRAILER (40 FT)

MISCELLANEOUS EQUIPMENT:

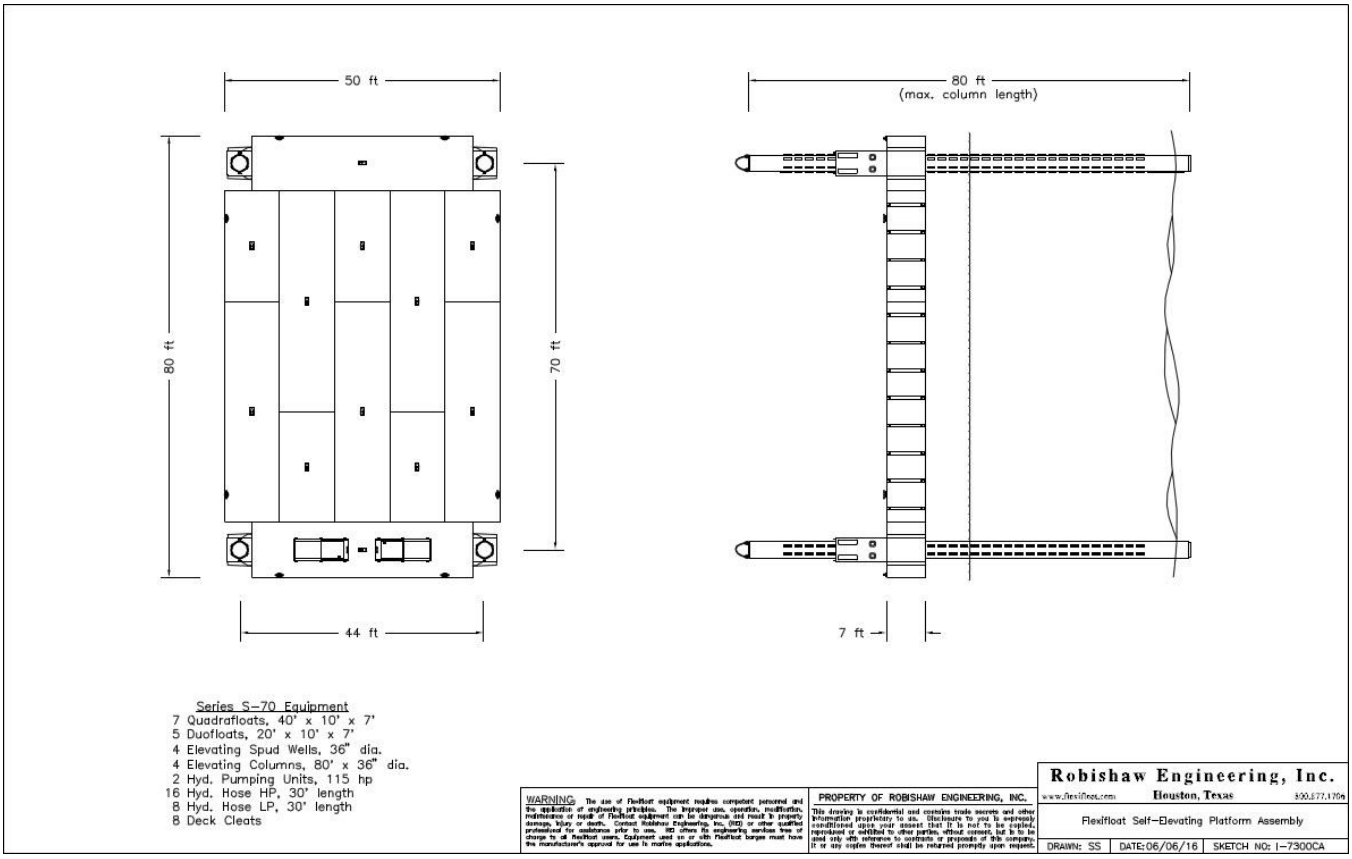
TENSOR STEER PROBE (SUPER PROBE)
2-30 FT MONEL DRILL COLLARS
JETTING ASSEMBLIES
ASSORTED FLY CUTTERS (REAMERS)
ASSORTED BARREL REAMERS
9000 FT S-135 (19.5 LB PER FT) **NEW DRILL PIPE**
PIPE TRAILERS
FLAT MUD HOSE (1500 FT) AND CAM LOCK FITTINGS
EXTRA HYD HOSES AND FITTINGS
EXTRA HYD PUMPS AND FITTINGS
EXTRA HYD MOTORS AND FITTINGS
SUBS
TONGS
HAND TOOLS
MISC SPARE PARTS: PUMP, HYD
(ESTIMATED $30K SPARES)
WELDER/UTILITY TRUCK (CREW CAB) CHEVY
¾ TON EXT. CAB TRUCK
6" CENTRIFUGAL PUMP GORMAN–RUPP
4" CENTRIFUGAL PUMP GORMAN-RUPP

ALL ENVIRONMENTAL CROSSINGS' EQUIPMENT IS MAINTAINED IN EXCELLENT OPERATIONAL AND COSMETIC CONDITION.

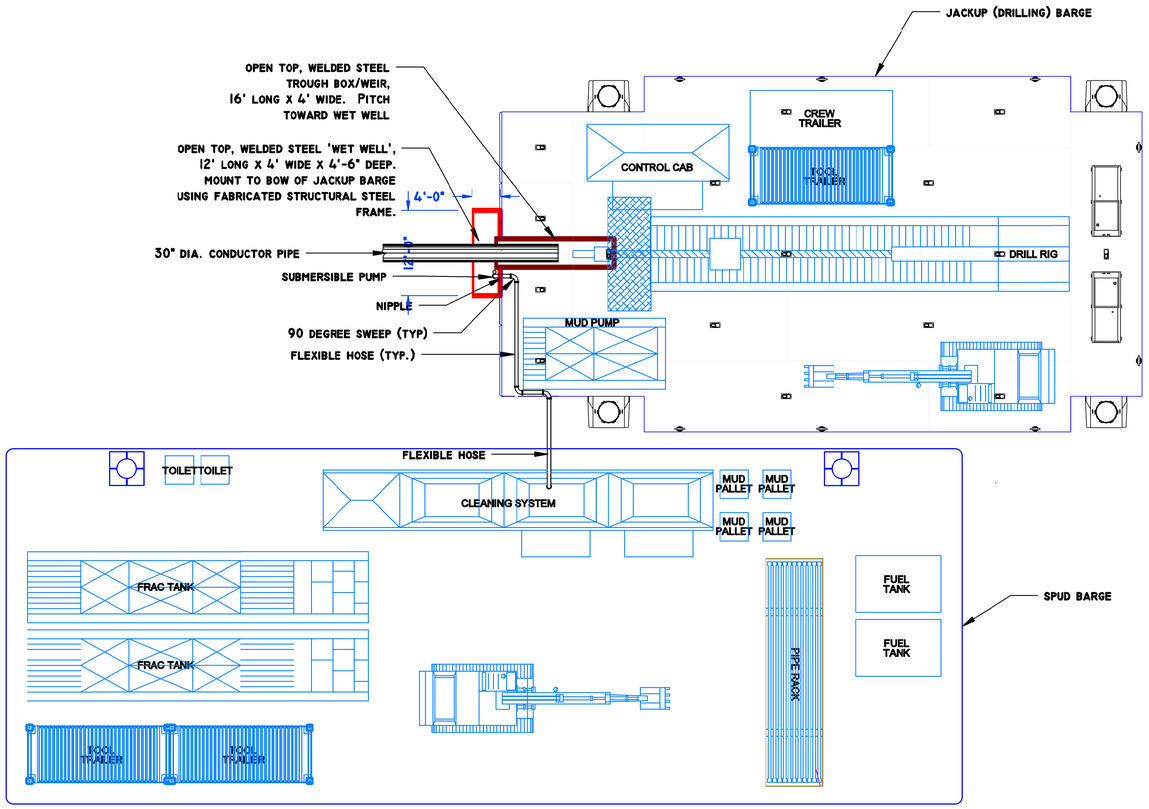
CaldwellMarine INTERNATIONAL
A JAG COMPANY



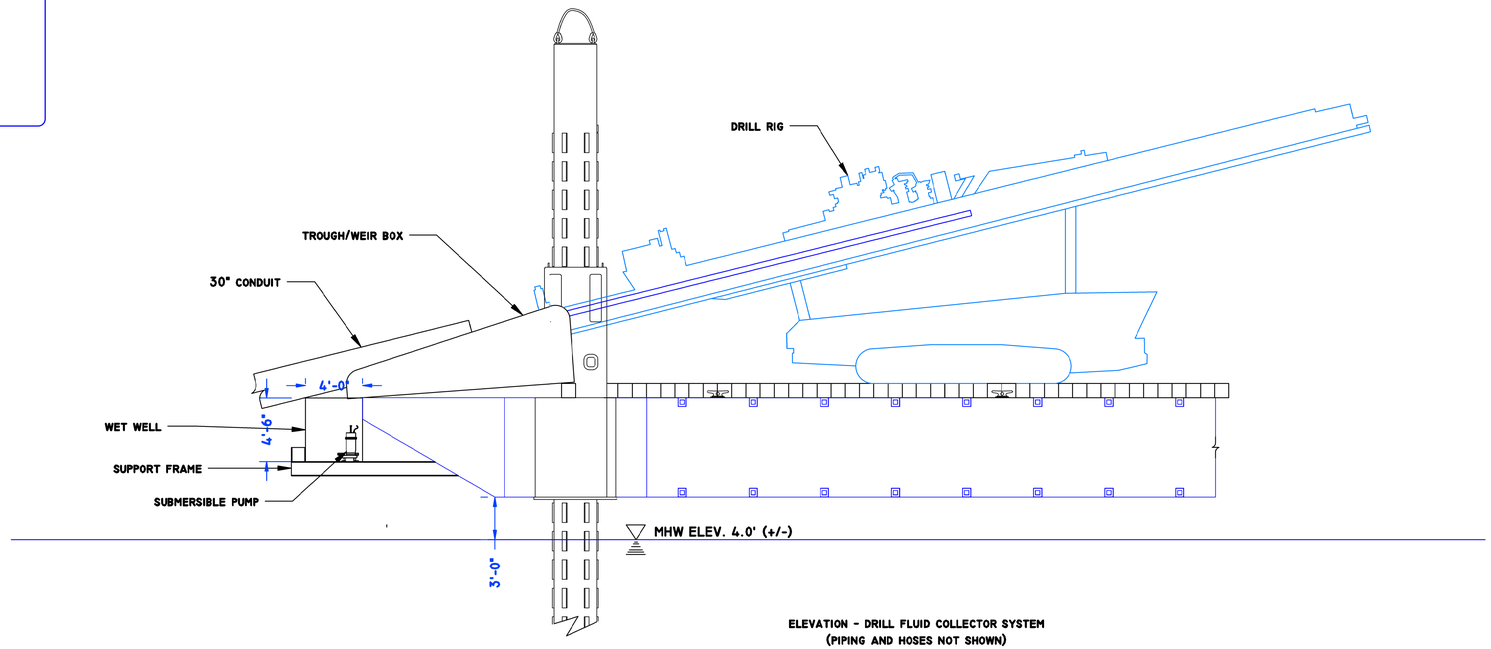
Flexi-Float Jack Up Barge



Flexi-Float Jack Up Barge Configuration



PLAN VIEW
DRILL FLUID COLLECTION SYSTEM
INSTALLED ON JACKUP DRILL BARGE



ELEVATION - DRILL FLUID COLLECTOR SYSTEM
(PIPING AND HOSES NOT SHOWN)
N.T.S.

No.	REVISION	DATE	BY

Caldwell
Marine International, LLC.
1433 Highway 34 South
Farmingdale, N.J. 07727
(732) 557-6100

Project: CHPE CONGERS HDD LANDING
Drawing Name: DRILL BARGE CONTAINMENT SYSTEM
Client:
Drawn By: DB/WMP — Date Drawn: 11/09/22
Approved By: WORKING — Date Approved: 11/09/22
Scale: 3/32" = 1'-0"
Project No.: PROJ NO.
Sheet No.: 1
Rev.: 0

CaldwellMarine INTERNATIONAL
A JAG COMPANY

ECI Drilling International, LLC
RIG NO. 9

ECI 330,000 LB RIG (1999)
EQUIPMENT LIST

ECI DD-330

Manufactured By:
AMERICAN AUGERS DIRECTIONAL DRILL:

THRUST - PULL BACK FORCE: 476,139 FT. LBS OF FORCE AT 6,000-PSI MAXIMUM HYDRAULIC PRESSURE.

ROTARY TORQUE: 50,419 FT LBS OF FORCE AT 4,500-PSI MAXIMUM HYDRAULIC PRESSURE.

RACK AND PINION THRUST/PULLBACK, TWO PINION DRIVE

PIPE SUPPORTS, HYDRAULICALLY OPERATED

INDEPENDENT CONTROLS AND HYDRAULIC CIRCUITS FOR THRUST/PULLBACK, TORQUE AND AUXILIARY OPERATIONS PERMITS SIMULTANEOUS FULL POWER OPERATION.

ADJUSTABLE TORQUE LIMITER FOR ROTARY AND MAKE UP FORCE.

CATERPILLAR DIESEL POWER

ADJUSTABLE FORCE LIMITER FOR THRUST AND PULLBACK

WRENCH/CLAMP SEPARATION 0-12 INCHES (0-305 MM) TRAVELS FULL LENGTH OF RACK

TRAILER MOUNTED ON AIR RIDE SUSPENSION, HIGH LEGAL LOAD.

WIRELINE COMMUTATOR FOR SPEEDY HOOKUP WIRELINE GUIDANCE EQUIPMENT WITH TERMINALS AT DRILL CONSOLE.

ESILOK LOCKOUT SYSTEM.

DRILLER'S CABIN WITH HEAT AND AIR CONDITIONING.

CaldwellMarine INTERNATIONAL
A JAG COMPANY

Mud System

ECI MUD SYSTEM:

E.C.I. DESIGN AND BUILT
200 BBL CAPACITY
3408 CAT POWERED
ALLISION TRANSMISSION (5 SPEED)
5 4" X 5" (50 HP) CHARGE AND MIXING PUMPS
ELLIS WILLIAMS 446 MUD PUMP (CAPACITY 460 GPM)
DE-SILTERS (1000 GPM)
DE-SANDERS (1000 GPM)
4 LINEAR TWO PANEL SHAKERS
150 GALLON FUEL CAPACITY
TRAILER MOUNTED (52 FT) NON PERMIT LOAD

DRILL PIPE: 31 FT AVG. S135 5" DRILL PIPE PREMIUM DOUBLE WHITE
4 ½ I.F. CONNECTION

CONTROL UNIT: WITH HEAT AND AIR CONDITIONING, POWER DISTRIBUTION PANEL WITH CIRCUIT BREAKERS, SURVERYOR'S TABLE. EXTERIOR STEEL SIDING. INSULATION 3-1/2" IN WALLS. EXTRA LARGE WINDOWS WITH VANDALISM SHIELDS. LIFTING EYES FOR JOB SITE MOBILITY.

TOOL VAN:
20' CONTAINER
AIR COMPRESSOR
MECHANICS SHOP
PARTS HOUSE

ROTARY DRIVE:

PINION AND GEAR DRIVE INFINITY VARIABLE TORQUE.
50,419 FT-LB (65,000 NM) @ 0-45 RPM ROTARY (HIGH TORQUE). 24,000 FT-LB (32,000 NM) @ 0-90 RPM ROTARY LOW TORQUE.
90 RPM MASIMUM ROTARY SPEED.

CaldwellMarine INTERNATIONAL
A JAG COMPANY

CARRIAGE DRIVE: MAXIMUM THRUST/PULLBACK - 476,139 FT-LBS AT 6,000 PSI MAXIMUM HYDRAULIC PRESSURE. RACK AND PINION, TWO PINION DRIVE, WITH ADJUSTABLE FORCE LIMITER CARRIAGE SYSTEM. 150 FT (45.7 M)/MIN MAXIMUM CARRIAGE SPEED.

PROTECTIVE EQUIPMENT:

DRILL COMES WITH SAFETY MATS AND ELECTRICAL GROUNDING RODS. A ZAP-ALERT SYSTEM IS STANDARD EQUIPMENT. EMERGENCY SHUT DOWN SWITCH AT DRILLER" CONSOLE AND AT REMOTE CONTROL CONSOLE. CARRIAGE OVER RIDE SWITCH DISABLES CARRIAGE DURING WIRELINE HOOKUP, MAINTENANCE, ETC. DRILL IS EQUIPPED WITH ES!LOK EXIT SIDE LOCKOUT SYSTEM.

MISCELLANEOUS EQUIPMENT:

TENSOR STEER PROBE (SUPER PROBE)
2-30 FT MONEL DRILL COLLARS
JETTING ASSEMBLIES
ASSORTED FLY CUTTERS (REAMERS)
ASSORTED BARREL REAMERS
9000 FT S-135 (19.5 LB PER FT) NEW DRILL PIPE
PIPE TRAILERS
6" CENTRIFUGAL SUMP PUMP

MISCELLANEOUS EQUIPMENT CONTINUED:

FLAT MUD HOSE (1500 FT) AND CAM LOCK FITTINGS
EXTRA HYD HOSES AND FITTINGS
EXTRA HYD PUMPS AND FITTINGS
EXTRA HYD MOTORS AND FITTINGS
SUBS
PIPE TONGS
HAND TOOLS
MISC SPARF, PARTS: PUMP, HYD
(ESTIMATED $30K SPARES)
CHEVY PICK UP (E.C.I. CREW CABS)
CHEVY PICKUP (WELDING TRUCK)
CATERPILLAR 3412 12-CYLINDER TURBO DIESEL, ENGINE AFTERCOOLED. RATED 740 HP (552 KW) CONTINUOUS DUTY. 300 U.S. GALLON (1135 LITRES) FUEL CAPACITY.
TRIAXLE TRAILER WITH AIR RIDE SUSPENSION, FIFTH WHEEL HITCH. [APPROXIMATE SHIPPING WEIGHT: 81,500 LB (37.00 KG).
WEIGHT WITHOUT WRENCHES: 74,650 LB (33,890 KG)].

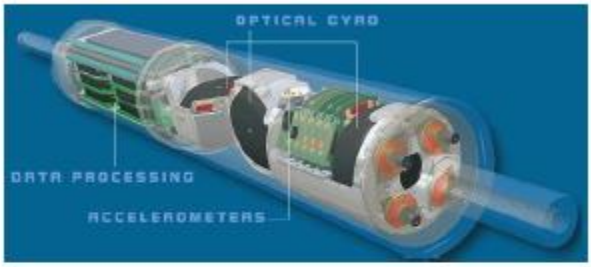
ALL ECI EQUIPMENT IS MAINTAINED IN EXCELLENT OPERATION AND COSMETIC CONDITION.

CaldwellMarine INTERNATIONAL
A JAG COMPANY

SlimDril International, Inc. • Brookshire, Texas • Phone: 281-391-5800 • www.slimdril.com

SLIMDRIL INTERNATIONAL

Drillguide GST GYRO STEERING TOOL



Technical Specifications –

Tool OD	6-5/8-inches	*	8-1/2-inches
API Tool Joint Connection (Box Up x Pin Down)	4-1/2 IF	*	6-5/8 FH
Maximum Allowed Torque (on Tool Housing)	18,000-ftlb	*	22,000-ftlb
Maximum Allowed Push/Pull (on Tool Housing)	75,000-pounds	*	105,000-pounds
Hole Size	8-1/2 – 9-7/8	*	10-5/8 – 12-1/4
Tool Weight	750-lbs	*	1,200-lbs
Tool Length (Shoulder to Shoulder)	8.7-ft		
Annular Pressure Sensor Position (From Pin Shoulder)	8.0-ft		
Electric Power (Input on Surface)	110-Volts AC / 60 Hz		
Electric Power (Output to Downhole Tool)	48 or 56-Volts DC		
Maximum Allowed Temperature (on Tool)	150-f		
Maximum Allowed Shock (on Tool)	50-g (half sine wave)		
Maximum Allowed Vibration (on Tool)	20-g up to 200-Hz		
Maximum Allowed Inner Mud Pressure (on Tool)	1250-psi		
Maximum Allowed Side Load (on Tool Housing)	33,000-pounds		

Sensor(s) Accuracy –

Azimuth	0.04°
Inclination	0.01°
Tool Face	0.02°

Tool Joint Recommended Makeup Torque –

6-5/8 GST	Housing = 18,000-ftlb	4-1/2 API Regular = 21,000-ftlb	4-1/2 API IF = 22,000-ftlb
8-1/2 GST	Housing = 22,000-ftlb	6-5/8 API Regular = 50,000-ftlb	6-5/8 API FH = 66,000-ftlb

For additional information - http://www.drillguide.com

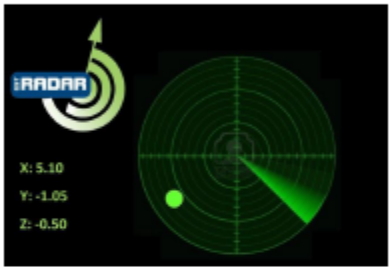
CaldwellMarine INTERNATIONAL
A JAG COMPANY

SlimDril International, Inc. • Brookshire, Texas • Phone: 281-391-5800 • www.slimdril.com

RADAR INTERSECT ASSEMBLY

The Drillguide GST guidance system is now expanded with the RADAR system. With this new system directly behind the GST it's possible to drill from both sides to make an underground intersect.

When the assemblies approach each other, the RADAR systems are activated. The systems determine their position relative to each other within tenths of feet. This makes it possible to drill one system to the borehole of the other, until the intersect is completed and both trajectories match.



Technical Specifications –

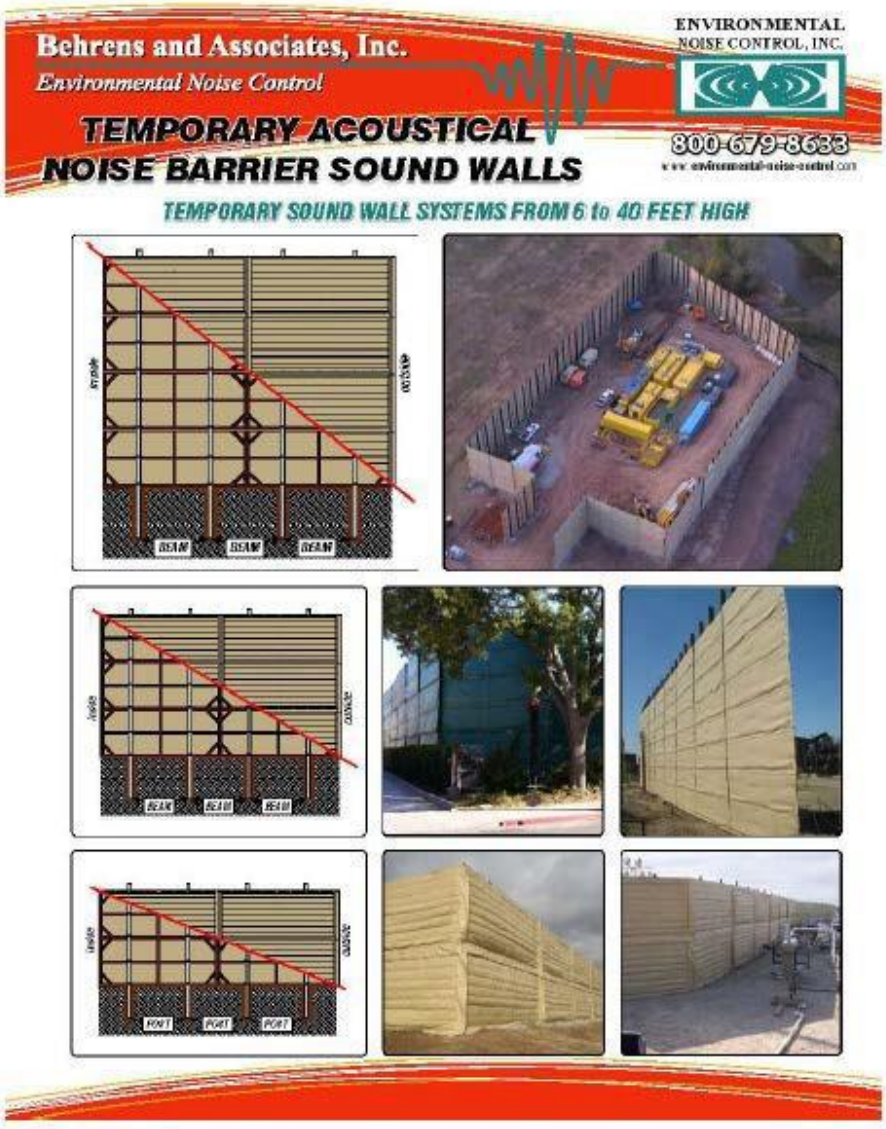
Tool OD	6-5/8-inches	*	8-1/2-inches
API Tool Joint Connection (Box Up x Pin Down)	4-1/2 IF	*	6-5/8 FH
Maximum Allowed Torque (on Tool Housing)	18,000-ftlb	*	22,000-ftlb
Maximum Allowed Push/Pull (on Tool Housing)	75,000-pounds	*	105,000-pounds
Hole Size	8-1/2 – 9-7/8	*	10-5/8 – 12-1/4
Tool Weight	750-lbs	*	1,200-lbs
Tool Length (Shoulder to Shoulder)	8.7-ft		
Electric Power (Input on Surface)	110-Volts AC / 60 Hz		
Electric Power (Output to Downhole Tool)	48 or 56-Volts DC		
Maximum Allowed Temperature (on Tool)	150-f		
Maximum Allowed Shock (on Tool)	50-g (half sine wave)		
Maximum Allowed Vibration (on Tool)	20-g up to 200-Hz		
Maximum Allowed Mud Pressure (on Tool)	650-psi		
Maximum Allowed Side Load (on Tool Housing)	33,000-pounds		

Tool Joint Recommended Makeup Torque –

6-5/8 GST	Housing = 18,000-ftlb	4-1/2 API Regular = 21,000-ftlb	4-1/2 API IF = 22,000-ftlb
8-1/2 GST	Housing = 22,000-ftlb	6-5/8 API Regular = 50,000-ftlb	6-5/8 API FH = 66,000-ftlb

For additional information - http://www.drillguide.com

Attachment 2 – Product Specification Sheet

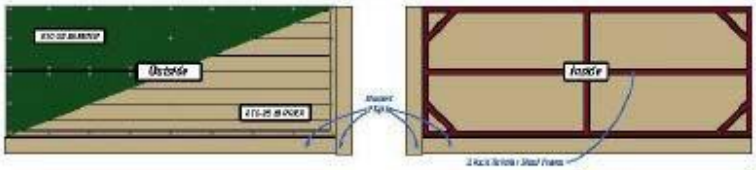


Attachment 2 – Product Specification Sheet (Continued)

TEMPORARY ACOUSTICAL NOISE BARRIER SOUND WALLS

800-679-8633
www.environmental-noise-control.com

SOUND WALL SYSTEMS IN STC-25 AND STC-32



ENC Style Temporary Noise Barrier sound wall systems are designed to provide optimum sound control in blocking and absorbing unwanted noise. At the heart of our sound wall systems are our ENC acoustical noise barrier blankets which are manufactured using state-of-the-art acoustical composite materials. The sound blankets are fabricated with polyvinyl-chloride coated outer shells; two layers of noise absorbing and blocking material; a specially developed inner core and septum barrier.

The modular design of ENC's temporary sound wall systems allow for quick and easy delivery, installation and removal of the temporary noise wall while meeting or exceeding structural code design requirements. The modular design of the temporary noise walls allows us to install noise barrier walls with heights ranging from 6 foot high to 40 foot high with gates, doors and emergency exits.

An independent acoustical laboratory has conducted tests in accordance with ASTM E-90 and ASTM E-413 requirements, to measure sound transmission loss and validating the Sound Transmission Class rating of STC-25 and STC-32.

The ENC composite barrier/absorber blankets, which are laboratory tested and certified, meet or exceed the specifications in the following tables:

BARRIER BLANKET SPECIFICATIONS

Oil resistant, UV resistant and anti-fungal, self-drying Poly-vinyl-chloride outer shells

Flame retardant to California Fire Marshall F-41.9.01 specifications

Conforms to California Construction Codes

After flame: 2 seconds

length of char: 3.5

Working temperature: -40 °F to +200 °F

Sound Transmission Class rated at STC-25 and STC-32 in accordance with ASTM E-413

SOUND TRANSMISSION LOSS DATA (dB)

⅓ Octave Band Center Frequency	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	
Transmission Loss	8 dB	10 dB	11 dB	10 dB	7 dB	7 dB	13 dB	17 dB	23 dB	28 dB	STC 25
⅓ Octave Band Center Frequency	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	
Transmission Loss	33 dB	36 dB	39 dB	41 dB	41 dB	40 dB	41 dB	44 dB	46 dB	50 dB	
⅓ Octave Band Center Frequency	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	
Transmission Loss	16 dB	20 dB	18 dB	16 dB	16 dB	17 dB	19 dB	23 dB	26 dB	32 dB	STC 32
⅓ Octave Band Center Frequency	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	
Transmission Loss	34 dB	35 dB	35 dB	36 dB	36 dB	36 dB	37 dB	39 dB	40 dB	43 dB	

PRINCIPAL OFFICES
TEXAS (Aledo) · COLORADO (Longmont) · CORPORATE OFFICE (Hawthorne, California)

SATELLITE OFFICES
PENNSYLVANIA (Washington) · LOUISIANA (Shreveport) · CALIFORNIA (Napa)

(800) 679 8633
(International +1 310 679 8633)

Internet: www.environmental-noise-control.com

For more information on applications or any of our quality rail cuts and services that we offer, please see our web site or call and speak to one of our ENC representatives. Rapid deployment to US and International.

ENVIRONMENTAL NOISE CONTROL, INC.

Allmand®

NIGHT-LITE PRO II®

LD-SERIES

The **Night-Lite Pro II® LD-Series™** features SHO-HD® lamp fixtures that provide 135,500 lumens per lamp – more than competitive light towers. The 30 gallon polyethylene fuel tank eliminates contamination from rust and corrosion to keep your light tower running longer. The optional full fluid containment system protects sensitive environments from inadvertent leaks and spills. Maximize your job site productivity with the choice that outshines the competition.

A SUBSIDIARY OF BRIGGS & STRATTON CORPORATION

KEY FEATURES

Night-Lite Pro II® LD-Series

Sequenced Light System (SLS™)
Automatically delays engine shutdown to turn off lights and prevent generator from shutting down while **under load.**

4 Metal Halide Lamps

359° Fixture Rotation

55 mph Operating Wind Speed Rating

Structure
3 section tubular steel design

Guide Pads
Polyethylene self-lubricating

Manual Winch Actuated Tower

Frame Formed, welded steel frame

Axle Tubular axle with elliptical leaf springs

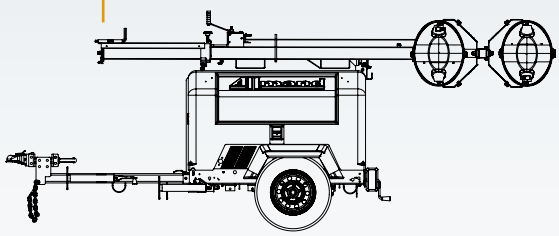
Removable Tongue

Reversible Coupler
Adjustable height
2" ball / 3" pintle

30 Gallon Polyethylene Fuel Tank

Stabilizers
Four-point design, tongue jack, (2) retractable side outriggers at front of trailer, rear jack

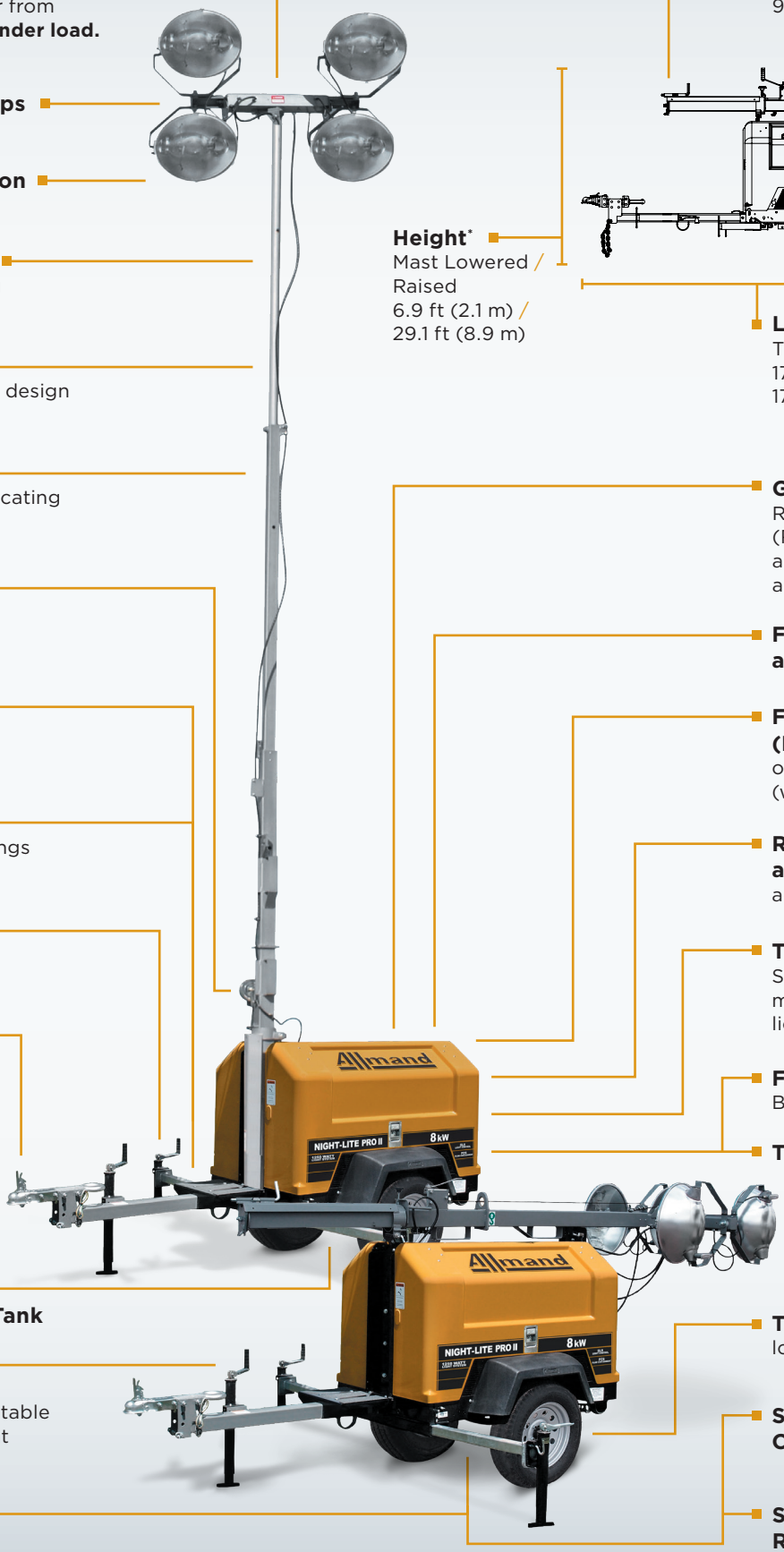
Four-Way Flat Trailer Connector



Width
Transport / Operating
50.5 in (1,283 mm) /
98.3 in (2,497 mm)

Height*
Mast Lowered / Raised
6.9 ft (2.1 m) /
29.1 ft (8.9 m)

Length
Transport / Operating
176.3 in (4,478 mm) /
173.3 in (4,402 mm)



Gull-Wing Style Doors
Reaction Injection Molded (RIM) doors providing strength and corrosion resistance with a lockable latch

Forklift Pockets and Lifting Eye

Fluid Containment System (FCS) Holding up to 110% of all on-board fluids (with Arctic Package)

Remote Engine Oil and Coolant Drain Easily accessible at rear of trailer

Trailer Lighting
Stop, turn, tail lights / side marker lights / illuminated license plate bracket

Forklift Pockets
Below the frame

Tie Down Rings

Tires ST175 / 80D13 load range 'C'

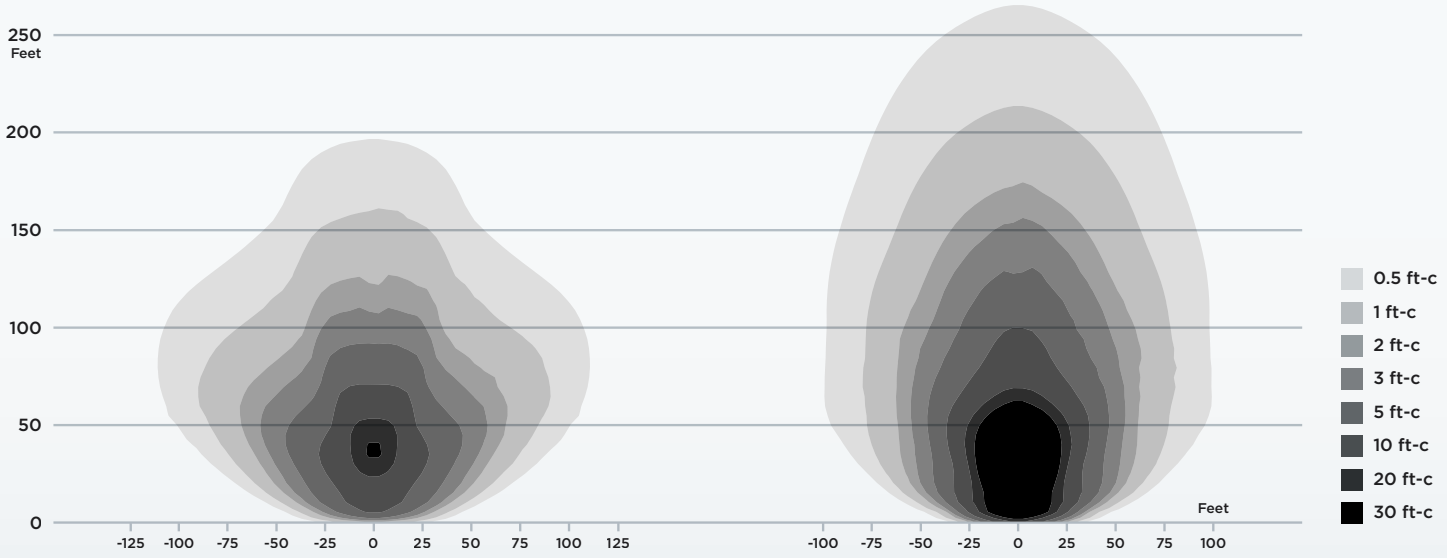
Seven-Way Round Pin Connector (SAE J560b Optional)

Seven-Way Flat Pin RV Adapter (Optional)

TECHNICAL SPECS

Model	NLPROLD-ML3E	NLPROLD-K1005	NLPROLD-P1.1
Engine Brand / Model	Mitsubishi / L3E	Kubota / D1005	Perkins / P1.1
Engine Prime Power (kW)**	6	7	8
Fuel Capacity gal (L)	30 (113.6)	30 (113.6)	30 (113.6)
Light Type – Metal Halide	(4) Metal Halide SHO-HD® fixture		
Metal Halide Wattage	1,250	1,250	1,250
Lumens (per lamp / total)	135,500 / 542,000	135,500 / 542,000	135,500 / 542,000
Operating Time (hrs)*** (Using four 1,250 W metal halide light fixtures)	50	48.4	50
Features			
Outlets	**Standard** 20 A 120 VAC duplex GFCI / 30 A 240 VAC 4-Wire Twist Lock (NEMA L14-30R) / 30 A 120 VAC RV (NEMA TT-30R)		
Weights & Shipping			
Shipping Weight lbs (kg)	1,720 (780.2)		
Gross Vehicle Weight Rating (GVWR) lbs (kg)	2,200 (998)		
Shipping	12 units on a 48' or 53' flatbed		

LIGHT COVERAGE



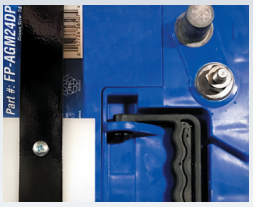
Night-Lite Pro II® LD-Series
with 4 – 320 W Conssin LED Light Output
Area Lit to .5 Foot Candle (ft-c) or Higher: 33,660 ft²

Night-Lite Pro II® LD-Series
with 4 – 1,250 W Metal Halide Light Output
Area Lit to .5 Foot Candle (ft-c) or Higher: 46,440 ft²

* Balloon light only included in raised dimension – balloon light is removed for transportation. ** Prime generator electrical output per Allmand® testing. *** Based on one hour run test full fuel tank consumption.
Allmand® has a policy of continuous product improvement and reserves the right to modify its specifications at any time and without prior notice. See operator's manual or www.allmand.com website for complete warranty details.

OPTIONS

Night-Lite Pro II® LD-Series



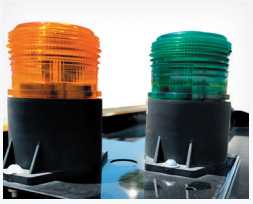
Arctic Package

- Heavy-duty battery 775 CCA @ 0° F
- Block heater (120 VAC)
- Fluid containment

LSC with E-Stop Package

(Not available with Mitsubishi Engine)

- LSC 2.1™ – Light Sequence Commander® automatically starts engine at sunset and shuts down engine at sunrise – programmable for user preferences.
- Emergency stop switch on exterior of machine



Arctic Max Package

(only available with Arctic Package)

- Heated fuel / water separator
- Radiator cover
- Low fuel shut-off system

AirStar Package

- Balloon Light features the AirStar Flex diffused lighting system using Allmand's exclusive bulbs. This system provides reduced glare while still illuminating a large area.

Engine Air Intake Shut-Off Valve (Not available with Mitsubishi or Perkins Engine)

Telematics Package (Customer supplied – consult factory)

Custom Paint

Skid Mount Available on Standard SKUs

2" Bull Dog (On Reversible Hitch) Feb 2019

CSA (Metal Halide)

COMPROMISE NOTHING.

At Allmand, our sole focus is providing jobsite support equipment to help your customers get the job done. Whenever they need it. Wherever they are. And whatever it takes. What's more, our genuine commitment to you — the highest standard of service and lowest total cost of ownership — is simply unmatched. Choose the equipment that comes with complete confidence that jobsite productivity won't go dark at 2 a.m. **Allmand. Above All.**

www.allmand.com

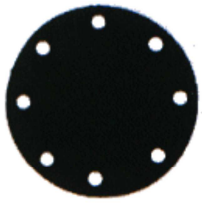
NLPROLD-0218

ALLMAND BROS., INC.
A subsidiary of Briggs & Stratton Corporation
P.O. Box 888, Holdrege, NE 68949

"Where Fabricated HDPE Fittings Are Endless"

HDPE Blind Flanges IPS & DIPS

(Dimensions in Inches)



Nominal Size	Diameter Of Flange	1" Thick Weight (lbs)	2" Thick Weight (lbs)
2"	6.00	1	2
3"	7.50	2	4
4"	9.00	3	6
6"	11.00	4	8
8"	13.50	5	10
10"	16.00	7	14
12"	19.00	10	20
14"	21.00	12	24
16"	23.50	15	30
18"	25.00	18	36
20"	27.50	21	42
22"	29.50	24	48
24"	32.00	28	56

These blind flanges are ordinarily used for closure or night-capping of flanged pipes. They are NOT fully pressure rated. Without the use of a metal back up blind flange, the HDPE flange may leak between bolt-holes at moderate pressures.

Also available manufactured from PVC material - Call For Quick Quote

Standard HDPE Blind Flanges are machined from PE4710 Resin HDPE Sheet and made to match ANSI B16.5 150# Bolt-Hole Pattern.

Custom Machining available to match ANSI Class 300# Bolt-Hole Pattern.

HDPE Fabricated Fittings supplied by Infinity Plastics are designed to meet AWWA C901/C906 fitting requirements and are manufactured from PPI and NSF listed resins in accordance with the material specification PE4710 listed in ASTM D3350 with a cell classification of 445574C or better. Suitable for butt welding to pipe manufactured to ASTM D2513, D3035, F714 with similar resins. *Pressure Ratings are calculated using 0.63 design factor for HDS at 73°F as listed in PPI TR-4 for PE4710 materials.

INFINITY PLASTICS 1124 Horicon St., Mayville, WI 53050
P 920-387-0200 / F 920-387-0300 / infinityplastics@sbcglobal.net

Appendix M– Marine Traffic Management Plan

CHPE SUBMARINE CABLE INSTALLATION
Marine Traffic Management Plan

Notice to Mariners
Prior to the start of operations CMI will issue a Notice to Mariners to the following agencies:

- Port Authority
- Vessel Traffic Control (VTC)
- US Coast Guard

The Notice to Mariners will include the following information:

- Vessels and equipment on site
- Work areas
- VHF contact channels for project vessels
- Nature of the work
- Identification and position of temporary can buoys at anchor locations

At the completion of the project an ending notice will be sent to the above agencies.

Automatic Identification System (AIS)
The support tug and the lay barge will both be equipped with AIS systems registered to each individual vessel.

Marine Communications
During the cable installation the support tug will be on the site at all times, and will be responsible for communication with other marine traffic and the VTC. At a minimum, daily reports will be made to the VTC regarding the schedule and nature of planned activities.

The support tug will maintain a radio watch on VHF Channels 16, 13, and the project working channel. The lay barge will maintain a radio watch on the working channel.

Ferries
Ferries will be advised daily of activities along the job site. Radio contact will be established with the ferries prior to crossing the ferry traffic lanes.

Appendix N– HDD Plan and Profile/Site Access Plan

Appendix O– Conductor Casing

Narrative for HDD / Conductor Casing Pipe Construction

Terrestrial side of HDD

1. Notify all appropriate parties in accordance with approved EM&CP.
2. Mobilize to site.
3. Establish soil erosion and sediment controls.
4. Prepare drill pad.
5. Layout drill entry points.
6. Set up drill and ancillary equipment.

Marine side of HDD

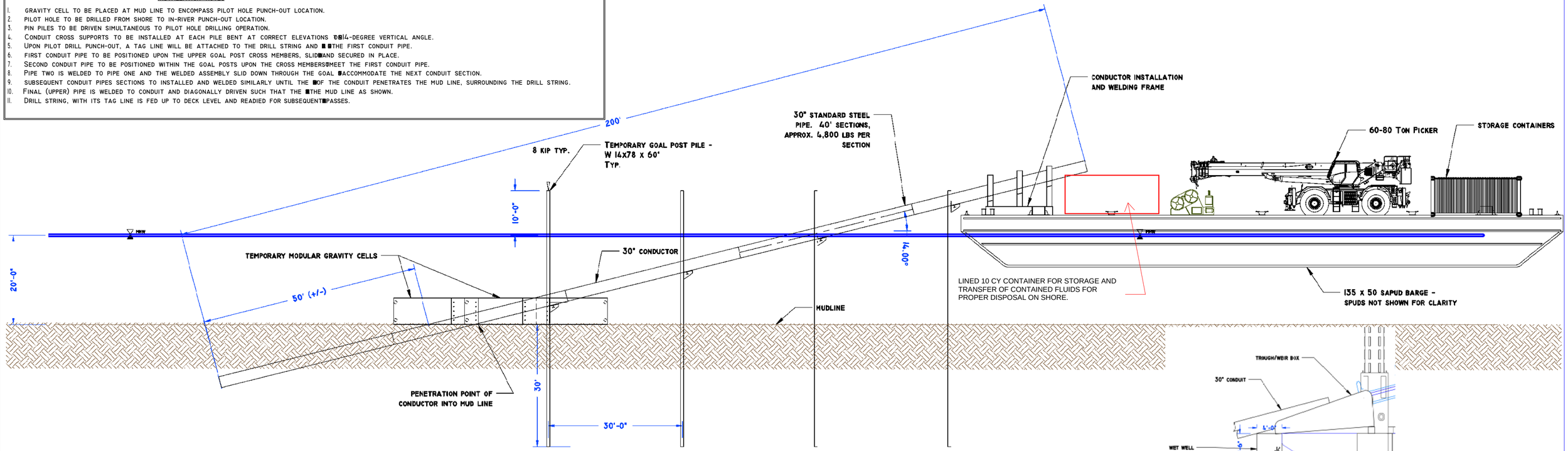
1. Issue Local Notice to Mariners notification to the US Coast Guard.
2. Notify all appropriate parties in accordance with approved EM&CP.
3. Mobilize marine assets.
4. Establish containment areas on deck of barge where steel riser pipe conductor casing is to exit.

Work sequence

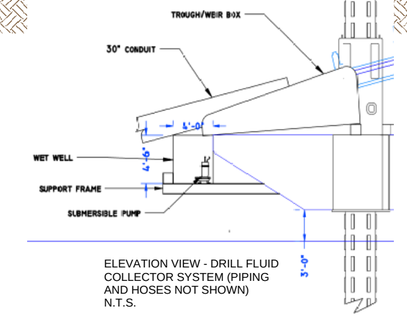
1. Rig up, begin 10” diameter pilot hole followed by 5-inch drill stem. Drill direction is from land towards water. Utilize drilling fluids contained in Appendix Q of this manual or approved equal.
2. Using guidance on drill, as the drill head nears penetrating the river bottom, switch from drilling fluids from Note 1 above to clean water. This will keep the drill fluid escaping on river bottom.
3. Complete pilot hole penetration of river bottom. See Section 6.2.5.3 of Installation Plan.
4. Locate drill exit hole.
5. Set gravity cell on river bottom using divers.
6. Layout/install “temporary goal post” support steel.
7. Layout/install steel conductor casing riser pipe to 14-degree slope onto support barge.
8. Advance the drill steel onto barge and remove pilot tool cutting head.
9. Push steel conductor casing riser pipe concentrically over 8” dia. pilot hole and into the river bottom. Divers to assist.
10. The steel conductor riser pipe now provides a closed system.
11. Install reaming tool on land side and begin forward reaming process. See Section 6.2.5.4 of Installation Plan.
12. Follow Appendix F and Appendix G for fraction mitigation and drilling fluid containment.
13. As the ream pass approaches the seabed/steel riser casing pipe, divers to monitor gravity cell for Inadvertent Returns (IR).
14. In event of IR in gravity cell, divers to utilize submersible pump with flexible hose to transfer drilling fluids to containment system on barge deck.
15. During the forward ream, drilling fluids will be recycled on land side. Process and stockpile cuttings on land side for future disposal.
16. Contain drilling fluids on deck of barge. Collect in holding tank. Transfer captured drilling fluids to truck to be properly disposed of.
17. During instances of harsh winters and freezing conditions, additional H-pile used for "temporary goal post supports" will be driven in a pattern up river from the marine assets and conductor casting to serve as ice breakers and protect the HDD entry/exit location.

INSTALLATION NOTES

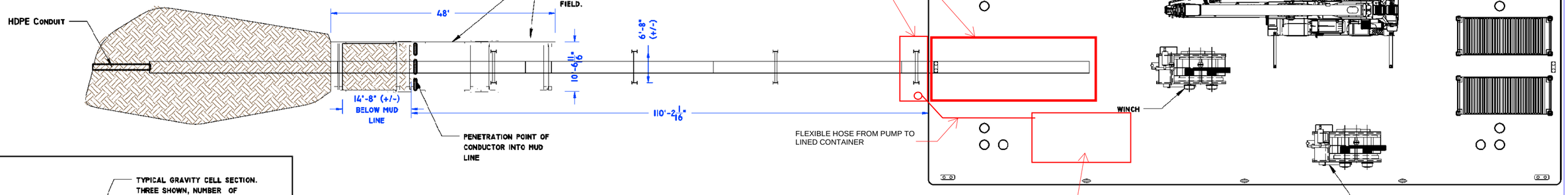
1. GRAVITY CELL TO BE PLACED AT MUD LINE TO ENCOMPASS PILOT HOLE PUNCH-OUT LOCATION.
2. PILOT HOLE TO BE DRILLED FROM SHORE TO IN-RIVER PUNCH-OUT LOCATION.
3. PIN PILES TO BE DRIVEN SIMULTANEOUS TO PILOT HOLE DRILLING OPERATION.
4. CONDUIT CROSS SUPPORTS TO BE INSTALLED AT EACH PILE BENT AT CORRECT ELEVATIONS TO A 14-DEGREE VERTICAL ANGLE.
5. UPON PILOT DRILL PUNCH-OUT, A TAG LINE WILL BE ATTACHED TO THE DRILL STRING AND PULLED THE FIRST CONDUIT PIPE.
6. FIRST CONDUIT PIPE TO BE POSITIONED UPON THE UPPER GOAL POST CROSS MEMBERS, SLID DOWN AND SECURED IN PLACE.
7. SECOND CONDUIT PIPE TO BE POSITIONED WITHIN THE GOAL POSTS UPON THE CROSS MEMBERS TO MEET THE FIRST CONDUIT PIPE.
8. PIPE TWO IS WELDED TO PIPE ONE AND THE WELDED ASSEMBLY SLID DOWN THROUGH THE GOAL POSTS TO ACCOMMODATE THE NEXT CONDUIT SECTION.
9. SUBSEQUENT CONDUIT PIPES SECTIONS TO INSTALLED AND WELDED SIMILARLY UNTIL THE TOP OF THE CONDUIT PENETRATES THE MUD LINE, SURROUNDING THE DRILL STRING.
10. FINAL (UPPER) PIPE IS WELDED TO CONDUIT AND DIAGONALLY DRIVEN SUCH THAT THE TOP IS AT THE MUD LINE AS SHOWN.
11. DRILL STRING, WITH ITS TAG LINE IS FED UP TO DECK LEVEL AND READIED FOR SUBSEQUENT PASSES.



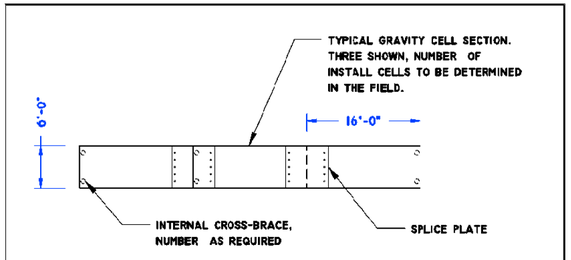
PROFILE
30" CONDUCTOR PIPE AND SUPPORTS



ELEVATION VIEW - DRILL FLUID COLLECTOR SYSTEM (PIPING AND HOSES NOT SHOWN) N.T.S.



PLAN VIEW
30" CONDUCTOR PIPE AND SUPPORTS



ELEVATION
TEMPORARY GRAVITY CELL ASSEMBLY

No.	REVISION	DATE	BY

Caldwell
Marine International, LLC.
1333 Campus Parkway
Wall Township, N.J. 07727
(732) 557-6100

Project: CHANMPLAIN-HUDSON EXPRESS
Drawing Name: 14 DEGREE CONDUCTOR PIPE/GOAL INSTALLATION
Client:
Drawn By: WHP — Date Drawn: 6/02/22
Approved By: — Date Approved: 6/03/22
Scale: 3/32" = 1'-0" — Project No.: 1229 — Sheet No.: 1 — Rev.: 0

Appendix P– Drilling Fluids Data

BORE-GEL®

Boring Fluid System – U.S. Patent Number 5,723,416

Description

BORE-GEL® single-sack boring fluid system is specially formulated for use in horizontal directional drilling (HDD) applications. BORE-GEL fluid system is a proprietary blended product using high-quality Wyoming sodium bentonite. When BORE-GEL fluid system is mixed with fresh water, it develops an easy-to-pump slurry with desirable fluid properties for HDD.

Applications/Functions

The use of BORE-GEL fluid system promotes the following:

- Optimum gel strength for cuttings suspension and transport
- Pumpable slurry with minimal viscosity
- High reactive solids concentration for improved borehole stability in poorly consolidated/cemented sands and gravel formations
- Reduced filtration via a thin filter cake with low permeability
- Lubrication of pipe in microtunneling operations

Advantages

- Minimizes the number of boring fluid products required
- Easy to mix and fast to yield
- Low viscosity minimizes pump pressures
- Provides lubricity for pulling product line
- Can be used in Water Wells in unconsolidated formations or when additional gel strengths are required to compensate for low annular velocity
- NSF/ANSI Standard 60 certified

Typical Properties

Appearance	Tan to gray powder
pH (4% slurry or 15 lb/bbl)	10.2
Bulk density, lb/ft^3	68 to 72 (compacted)

Rev. 2/24/2011 · IDP 032

Recommended Treatment

Add slowly and uniformly through a high-shear, jet-type mixer over one or more cycles of the volume of slurry. Continue to circulate and agitate the slurry until all unyielded bentonite is dispersed.

Approximate amounts of BORE-GEL® fluid system added to fresh water		
Boring Application	**lb/100 gal**	**kg/m^3**
Normal boring conditions	25 – 35	30 – 42
Poorly consolidated sand/gravel	35 – 60	42 – 72
Lubrication fluid for microtunneling	50 – 60	60 – 72

Packaging

BORE-GEL boring fluid system is packaged in a 50-lb (23-kg) multiwall paper bag.

Availability

BORE-GEL boring fluid system can be purchased through any Baroid Industrial Drilling Products Retailer. To locate the Baroid IDP retailer nearest you contact the Customer Service Department in Houston or your area IDP Sales Representative.

Baroid Industrial Drilling Products
Product Service Line, Halliburton
3000 N. Sam Houston Pkwy. E.
Houston, TX 77032

Customer Service	(800) 735-6075 Toll Free	(281) 871-4612
Technical Service	(877) 379-7412 Toll Free	(281) 871-4613

HALLIBURTON

MATERIAL SAFETY DATA SHEET

Product Trade Name: **BORE-GEL®**

Revision Date: 20-Mar-2015

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Trade Name: BORE-GEL®
Synonyms: None
Chemical Family: Mineral
Application: Viscosifier

Manufacturer/Supplier
Baroid Fluid Services
Product Service Line of Halliburton
P.O. Box 1675
Houston, TX 77251
Telephone: (281) 871-4000
Emergency Telephone: (281) 575-5000

Prepared By
Chemical Stewardship
Telephone: 1-580-251-4335
e-mail: fdunexchem@halliburton.com

2. COMPOSITION/INFORMATION ON INGREDIENTS

Substances	CAS Number	PERCENT (w/w)	ACGIH TLV-TWA	OSHA PEL-TWA
Bentonite	1302-78-9	60 - 100%	TWA: 1 mg/m^3	Not applicable
Crystalline silica, quartz	14808-60-7	1 - 5%	TWA: 0.025 mg/m^3	$\frac{10\ mg/m^3}{\%SiO2 + 2}$
Crystalline silica, cristobalite	14464-46-1	0.1 - 1%	TWA: 0.025 mg/m^3	1/2 x $\frac{10\ mg/m^3}{\%SiO2 + 2}$
Crystalline silica, tridymite	15468-32-3	0.1 - 1%	0.05 mg/m^3	1/2 x $\frac{10\ mg/m^3}{\%SiO2 + 2}$

3. HAZARDS IDENTIFICATION

Hazard Overview

CAUTION! - ACUTE HEALTH HAZARD
May cause eye and respiratory irritation.

DANGER! - CHRONIC HEALTH HAZARD
Breathing crystalline silica can cause lung disease, including silicosis and lung cancer. Crystalline silica has also been associated with scleroderma and kidney disease.

This product contains quartz, cristobalite, and/or tridymite which may become airborne without a visible cloud. Avoid breathing dust. Avoid creating dusty conditions. Use only with adequate ventilation to keep exposures below recommended exposure limits. Wear a NIOSH certified, European Standard EN 149, AS/NZS 1715, or equivalent respirator when using this product. Review the Safety Data Sheet (SDS) for this product, which has been provided to your employer.

4. FIRST AID MEASURES

Inhalation If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Skin Wash with soap and water. Get medical attention if irritation persists.

Eyes In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.

Ingestion Under normal conditions, first aid procedures are not required.

Notes to Physician Treat symptomatically.

5. FIRE FIGHTING MEASURES

Flash Point/Range (F):	Not Determined
Flash Point/Range (C):	Not Determined
Flash Point Method:	Not Determined
Autoignition Temperature (F):	Not Determined
Autoignition Temperature (C):	Not Determined
Flammability Limits in Air - Lower (%):	Not Determined
Flammability Limits in Air - Upper (%):	Not Determined

Fire Extinguishing Media All standard firefighting media.

Special Exposure Hazards Not applicable.

Special Protective Equipment for Fire-Fighters Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

NFPA Ratings: Health 0, Flammability 0, Reactivity 0
HMIS Ratings: Health 0*, Flammability 0, Physical Hazard 0 , PPE: At

6. ACCIDENTAL RELEASE MEASURES

Personal Precautionary Measures Use appropriate protective equipment. Avoid creating and breathing dust.

Environmental Precautionary Measures Prevent from entering sewers, waterways, or low areas.

Procedure for Cleaning / Absorption	Collect using dustless method and hold for appropriate disposal. Consider possible toxic or fire hazards associated with contaminating substances and use appropriate methods for collection, storage and disposal.

7. HANDLING AND STORAGE

Handling Precautions	This product contains quartz, cristobalite, and/or tridymite which may become airborne without a visible cloud. Avoid breathing dust. Avoid creating dusty conditions. Use only with adequate ventilation to keep exposure below recommended exposure limits. Wear a NIOSH certified, European Standard En 149, or equivalent respirator when using this product. Material is slippery when wet.
Storage Information	Use good housekeeping in storage and work areas to prevent accumulation of dust. Close container when not in use. Do not reuse empty container. Product has a shelf life of 12 months.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls	Use approved industrial ventilation and local exhaust as required to maintain exposures below applicable exposure limits.
Personal Protective Equipment	If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.
Respiratory Protection	Not normally needed. But if significant exposures are possible then the following respirator is recommended: Dust/mist respirator. (N95, P2/P3)
Hand Protection	Normal work gloves.
Skin Protection	Wear clothing appropriate for the work environment. Dusty clothing should be laundered before reuse. Use precautionary measures to avoid creating dust when removing or laundering clothing.
Eye Protection	Wear safety glasses or goggles to protect against exposure.
Other Precautions	None known.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State:	Powder
Color:	Light brown or Gray
Odor:	Mild earthy
pH:	8-10
Specific Gravity @ 20 C (Water=1):	2.5
Density @ 20 C (lbs./gallon):	Not Determined
Bulk Density @ 20 C (lbs/ft3):	53 - 80
Boiling Point/Range (F):	Not Determined
Boiling Point/Range (C):	Not Determined
Freezing Point/Range (F):	Not Determined
Freezing Point/Range (C):	Not Determined
Vapor Pressure @ 20 C (mmHg):	Not Determined
Vapor Density (Air=1):	Not Determined

Percent Volatiles:	Not Determined
Evaporation Rate (Butyl Acetate=1):	Not Determined
Solubility in Water (g/100ml):	Slightly soluble
Solubility in Solvents (g/100ml):	Not Determined
VOCs (lbs./gallon):	Not Determined
Viscosity, Dynamic @ 20 C (centipoise):	Not Determined
Viscosity, Kinematic @ 20 C (centistokes):	Not Determined
Partition Coefficient/n-Octanol/Water:	Not Determined
Molecular Weight (g/mole):	Not Determined

10. STABILITY AND REACTIVITY

Stability Data: Stable

Hazardous Polymerization: Will Not Occur

Conditions to Avoid None anticipated

Incompatibility (Materials to Avoid) Hydrofluoric acid.

Hazardous Decomposition Products Amorphous silica may transform at elevated temperatures to tridymite (870 C) or cristobalite (1470 C).

Additional Guidelines Not Applicable

11. TOXICOLOGICAL INFORMATION

Principle Route of Exposure Eye or skin contact, inhalation.

Sympotoms related to exposure

Acute Toxicity

Inhalation

Inhaled crystalline silica in the form of quartz or cristobalite from occupational sources is carcinogenic to humans (IARC, Group 1). There is sufficient evidence in experimental animals for the carcinogenicity of tridymite (IARC, Group 2A).

Breathing silica dust may cause irritation of the nose, throat, and respiratory passages. Breathing silica dust may not cause noticeable injury or illness even though permanent lung damage may be occurring. Inhalation of dust may also have serious chronic health effects (See "Chronic Effects/Carcinogenicity" subsection below).

Eye Contact	May cause eye irritation.
Skin Contact	May cause mechanical skin irritation.
Ingestion	None known

Chronic Effects/Carcinogenicity

Silicosis: Excessive inhalation of respirable crystalline silica dust may cause a progressive, disabling, and sometimes-fatal lung disease called silicosis. Symptoms include cough, shortness of breath, wheezing, non-specific chest illness, and reduced pulmonary function. This disease is exacerbated by smoking. Individuals with silicosis are predisposed to develop tuberculosis.

Cancer Status: The International Agency for Research on Cancer (IARC) has determined that crystalline silica inhaled in the form of quartz or cristobalite from occupational sources can cause lung cancer in humans (Group 1 - carcinogenic to humans) and has determined that there is sufficient evidence in experimental animals for the carcinogenicity of tridymite (Group 2A - possible carcinogen to humans). Refer to IARC Monograph 68, Silica, Some Silicates and Organic Fibres (June 1997) in conjunction with the use of these minerals. The National Toxicology Program classifies respirable crystalline silica as "Known to be a human carcinogen". Refer to the 9th Report on Carcinogens (2000). The American Conference of Governmental Industrial Hygienists (ACGIH) classifies crystalline silica, quartz, as a suspected human carcinogen (A2).

There is some evidence that breathing respirable crystalline silica or the disease silicosis is associated with an increased incidence of significant disease endpoints such as scleroderma (an immune system disorder manifested by scarring of the lungs, skin, and other internal organs) and kidney disease.

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Bentonite	1302-78-9	> 5000 mg/kg (Rat) > 2000 mg/kg (Rat)	No data available	> 5.27 mg/L (Rat)
Crystalline silica, quartz	14808-60-7	500 mg/kg (Rat) >15,000 mg/kg (Human)	No data available	No data available
Crystalline silica, cristobalite	14464-46-1	> 5000 mg/kg (Rat)	No data available	No data available
Crystalline silica, tridymite	15468-32-3	> 5000 mg/kg (Rat)	No data available	No data available

12. ECOLOGICAL INFORMATION

Ecotoxicological Information

Ecotoxicity Product

Acute Fish Toxicity: TLM96: 10000 ppm (Oncorhynchus mykiss)
Acute Crustaceans Toxicity: Not determined
Acute Algae Toxicity: Not determined

Ecotoxicity Substance

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Bentonite	1302-78-9	EC50(72h): > 100 mg/L (freshwater algae)	TLM96 10,000 ppm (Oncorhynchus mykiss) LC50 (96h) 16,000 - 19,000 mg/L (Oncorhynchus mykiss) LC50 (24h) 2800 – 3200 mg/L (black bass, warmouth bass, blue gill and sunfish)	No information available	EC50 (96h) 81.6 mg/L (Metacarcinus magister) EC50 (96h) 24.8 mg/L (Pandalus danae) EC50 (48h) > 100 mg/L (Daphnia magna)
Crystalline silica, quartz	14808-60-7	No information available	LL0 (96h) 10,000 mg/L (Danio rerio) (similar substance)	No information available	LL50 (24h) > 10,000 mg/L (Daphnia magna) (similar substance)
Crystalline silica, cristobalite	14464-46-1	No information available	LL0 (96h) 10,000 mg/L (Danio rerio) (similar substance)	No information available	LL50 (24h) > 10,000 mg/L (Daphnia magna) (similar substance)

Crystalline silica, tridymite	15468-32-3	No information available	LL0 (96h) 10,000 mg/L(Danio rerio) (similar substance)	No information available	LL50 (24h) > 10,000 mg/L (Daphnia magna) (similar substance)

12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Bentonite	1302-78-9	The methods for determining biodegradability are not applicable to inorganic substances.
Crystalline silica, quartz	14808-60-7	The methods for determining biodegradability are not applicable to inorganic substances.
Crystalline silica, cristobalite	14464-46-1	The methods for determining biodegradability are not applicable to inorganic substances.
Crystalline silica, tridymite	15468-32-3	The methods for determining biodegradability are not applicable to inorganic substances.

12.3. Bioaccumulative potential

Substances	CAS Number	Log Pow
Bentonite	1302-78-9	No information available
Crystalline silica, quartz	14808-60-7	No information available
Crystalline silica, cristobalite	14464-46-1	No information available
Crystalline silica, tridymite	15468-32-3	No information available

12.4. Mobility in soil
No information available

12.5. Results of PBT and vPvB assessment
No information available.

Substances	PBT and vPvB assessment
Bentonite	No data available
Crystalline silica, quartz	Not PBT/vPvB
Crystalline silica, cristobalite	No data available
Crystalline silica, tridymite	No data available

12.6. Other adverse effects
No information available

13. DISPOSAL CONSIDERATIONS

Disposal Method If practical, recover and reclaim, recycle, or reuse by the guidelines of an approved local reuse program. Should contaminated product become a waste, dispose of in a licensed industrial landfill according to federal, state, and local regulations.

Contaminated Packaging Follow all applicable national or local regulations.

14. TRANSPORT INFORMATION

US DOT

UN Number: Not restricted
UN Proper Shipping Name: Not restricted
Transport Hazard Class(es): Not applicable
Packing Group: Not applicable

US DOT Bulk

DOT (Bulk) Not applicable

Canadian TDG

UN Number: Not restricted
UN Proper Shipping Name: Not restricted
Transport Hazard Class(es): Not applicable
Packing Group: Not applicable

IMDG/IMO

UN Number: Not restricted
UN Proper Shipping Name: Not restricted
Transport Hazard Class(es): Not applicable
Packing Group: Not applicable

IATA/ICAO

UN Number: Not restricted
UN Proper Shipping Name: Not restricted
Transport Hazard Class(es): Not applicable
Packing Group: Not applicable

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code: Not applicable
Special Precautions for User: None

15. REGULATORY INFORMATION

US Regulations

US TSCA Inventory — All components listed on inventory or are exempt.

EPA SARA Title III Extremely Hazardous Substances — Not applicable

EPA SARA (311,312) Hazard Class — Acute Health Hazard
Chronic Health Hazard

EPA SARA (313) Chemicals — This product does not contain a toxic chemical for routine annual "Toxic Chemical Release Reporting" under Section 313 (40 CFR 372).

EPA CERCLA/Superfund Reportable Spill Quantity — Not applicable.

EPA RCRA Hazardous Waste Classification — If product becomes a waste, it does NOT meet the criteria of a hazardous waste as defined by the US EPA.

California Proposition 65 — The California Proposition 65 regulations apply to this product.

MA Right-to-Know Law — One or more components listed.

NJ Right-to-Know Law — One or more components listed.

PA Right-to-Know Law — One or more components listed.

Canadian Regulations

Canadian DSL Inventory — All components listed on inventory or are exempt.

WHMIS Hazard Class — D2A Very Toxic Materials
Crystalline silica

16. OTHER INFORMATION

The following sections have been revised since the last issue of this SDS
Not applicable

Additional information

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

Disclaimer Statement

This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

*****END OF MSDS*****

QUIK-GEL®

Viscosifier

Description

QUIK-GEL® viscosifier is an easy-to-mix, finely ground (200-mesh), premium-grade, high-yielding Wyoming sodium bentonite. QUIK-GEL viscosifier imparts viscosity, fluid loss control and gelling characteristics to freshwater-based drilling fluids.

Applications/Functions

The use of QUIK-GEL viscosifier promotes or assists the following:

- Mix with fresh water to form a low-solids drilling fluid for general drilling applications
- Viscosify water-based drilling fluids
- Reduce filtration by forming a thin filter cake with low permeability
- Improve hole-cleaning capability of drilling fluids
- Mix with foaming agents to make "gel/foam" drilling fluids for air/foam drilling applications

Advantages

- NSF/ANSI Standard 60 certified
- Single-sack product and cost effective
- Can provide lubricity for drilling fluids
- Can mix easily and quickly reaches maximum viscosity
- Can yield more than twice as much mud of the same viscosity as an equal weight of API oilfield grades of bentonite

Typical Properties

• Appearance	Grey to tan powder
• Bulk density, lb/ft^3	68 to 72 (compacted)
• pH (3% solution)	8.9

Recommended Treatment

Mix slowly through a jet mixer or sift slowly into the vortex of a high-speed stirrer.

Approximate Amounts of QUIK-GEL viscosifier Added to Freshwater			
Application/Desired Result	**lb/100 gal**	**lb/bbl**	**kg/m^3**
Normal Drilling Conditions	15-25	6-10	18-30
Unconsolidated Formations	35-50	15-21	42-60
Make-Up For Gel/Foam Systems	12-15	5-7	14-18

- 1 bbl = 42 U.S. gallons

Rev. 03/2011 · IDP 009

Additional Information

***Note*:**

- For optimum yield, pre-treat make-up water with 1-2 pounds of soda ash per 100 gallons of water (1.2-2.4 kg/m^3).

Packaging

QUIK-GEL viscosifier is packaged in 50-lb (22.7-kg) multiwall paper bags.

Availability

QUIK-GEL viscosifier can be purchased through any Baroid Industrial Products Retailer. To locate the Baroid IDP retailer nearest you contact the Customer Service Department in Houston or your area IDP Sales Representative.

Baroid Industrial Drilling Products

Product Service Line, Halliburton

3000 N. Sam Houston Pkwy. E.

Houston, TX 77032

Customer Service	(800) 735-6075 Toll Free	(281) 871-4612
Technical Service	(877) 379-7412 Toll Free	(281) 871-4613

HALLIBURTON

SAFETY DATA SHEET

Product Trade Name: **QUIK-GEL®**

Revision Date: 14-Aug-2017 **Revision Number:** 20

1. Identification

1.1. Product Identifier

Product Trade Name: QUIK-GEL®
Synonyms None
Chemical Family: Mineral
Internal ID Code HM003747

1.2 Recommended use and restrictions on use

Application: Viscosifier
Uses advised against No information available

1.3 Manufacturer's Name and Contact Details

Manufacturer/Supplier
Baroid Fluid Services
Product Service Line of Halliburton Energy Services, Inc.
P.O. Box 1675
Houston, TX 77251
Telephone: (281) 871-4000

Halliburton Energy Services, Inc.
645 - 7th Ave SW Suite 1800
Calgary, AB
T2P 4G8
Canada

Prepared By Chemical Stewardship
Telephone: 1-281-871-6107
e-mail: fdunexchem@halliburton.com

1.4. Emergency telephone number:

Emergency Telephone Number 1-866-519-4752 or 1-760-476-3962
Global Incident Response Access Code: 334305
Contract Number: 14012

2. Hazards Identification

2.1 Classification in accordance with paragraph (d) of §1910.1200

Carcinogenicity	Category 1A - H350
Specific Target Organ Toxicity - (Repeated Exposure)	Category 1 - H372

2.2. Label Elements

Hazard Pictograms

Signal Word: Danger

Hazard Statements
H350 - May cause cancer by inhalation
H372 - Causes damage to organs through prolonged or repeated exposure if inhaled

Precautionary Statements

Prevention
P201 - Obtain special instructions before use
P202 - Do not handle until all safety precautions have been read and understood
P260 - Do not breathe dust/fume/gas/mist/vapors/spray
P264 - Wash face, hands and any exposed skin thoroughly after handling
P270 - Do not eat, drink or smoke when using this product
P280 - Wear protective gloves/protective clothing/eye protection/face protection

Response
P308 + P313 - IF exposed or concerned: Get medical advice/attention
P314 - Get medical attention/advice if you feel unwell

Storage
P405 - Store locked up

Disposal
P501 - Dispose of contents/container in accordance with local/regional/national/international regulations

2.3 Hazards not otherwise classified

This product contains Wyoming bentonite or other sorptive clays. Crystalline silica forms found in this particular clay are limited to quartz. Extreme temperatures that can generate cristobalite or tridymite are not expected to occur under realistic conditions. In addition, all quartz found in sorptive clays are considered "occluded", i.e., strongly coated with an amorphous silica surface. Occluded quartz has been experimentally-determined to be relatively non-toxic compared to unoccluded quartz. A lack of health effects found in several studies examining occupational exposure to sorptive clays also suggest that chronic inhalation of sorptive clays is not expected to result in silicosis or cancer. In light of these findings OSHA has recently exempted Wyoming bentonite and other sorptive clays from the crystalline silica PEL in §1910.1053(a)(1)(iii).

3. Composition/information on Ingredients

Substances	CAS Number	PERCENT (w/w)	GHS Classification - US
Crystalline silica, quartz	14808-60-7	1 - 5%	Carc. 1A (H350) STOT RE 1 (H372)

The exact percentage (concentration) of the composition has been withheld as proprietary.

4. First Aid Measures

4.1. Description of first aid measures

Inhalation If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Eyes In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.

Skin Wash with soap and water. Get medical attention if irritation persists.

Ingestion Rinse mouth with water many times.

4.2 Most important symptoms/effects, acute and delayed

Breathing crystalline silica can cause lung disease, including silicosis and lung cancer. Crystalline silica has also been associated with scleroderma and kidney disease.

4.3. Indication of any immediate medical attention and special treatment needed

Notes to Physician Treat symptomatically.

5. Fire-fighting measures

5.1. Extinguishing media

Suitable Extinguishing Media

All standard fire fighting media

Extinguishing media which must not be used for safety reasons

None known.

5.2 Specific hazards arising from the substance or mixture

Special exposure hazards in a fire

None anticipated

5.3 Special protective equipment and precautions for fire-fighters

Special protective equipment for firefighters

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

6. Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Use appropriate protective equipment. Avoid creating and breathing dust. Ensure adequate ventilation. Avoid contact with skin, eyes and clothing.

See Section 8 for additional information

6.2. Environmental precautions

Prevent from entering sewers, waterways, or low areas.

6.3. Methods and material for containment and cleaning up

Collect using dustless method and hold for appropriate disposal. Consider possible toxic or fire hazards associated with contaminating substances and use appropriate methods for collection, storage and disposal.

7. Handling and storage

7.1. Precautions for safe handling

Handling Precautions

This product contains quartz, cristobalite, and/or tridymite which may become airborne without a visible cloud. Avoid breathing dust. Avoid creating dusty conditions. Use only with adequate ventilation to keep exposure below recommended exposure limits. Wear a NIOSH certified, European Standard En 149, or equivalent respirator when using this product. Material is slippery when wet. Use appropriate protective equipment.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities

Storage Information

Use good housekeeping in storage and work areas to prevent accumulation of dust. Close container when not in use. Keep from excessive heat. Do not reuse empty container. Product has a shelf life of 36 months.

8. Exposure Controls/Personal Protection

8.1 Occupational Exposure Limits

Substances	CAS Number	OSHA PEL-TWA	ACGIH TLV-TWA
Crystalline silica, quartz	14808-60-7	TWA: 50 µg/m³	TWA: 0.025 mg/m³

Exposures to crystalline silica that result from bentonite or other sorptive clays are exempt from the PEL in §1910.1053. The PEL in §1910.1000 Table Z–3 (i.e., the formula that is approximately equivalent to 100 µg/m³) applies to occupational exposures to respirable crystalline silica from sorptive clays.

8.2 Appropriate engineering controls

Engineering Controls Use approved industrial ventilation and local exhaust as required to maintain exposures below applicable exposure limits.

8.3 Individual protection measures, such as personal protective equipment

Personal Protective Equipment If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

Respiratory Protection Not normally needed. But if significant exposures are possible then the following respirator is recommended:
Dust/mist respirator. (N95, P2/P3)

Hand Protection Normal work gloves.

Skin Protection Wear clothing appropriate for the work environment. Dusty clothing should be laundered before reuse. Use precautionary measures to avoid creating dust when removing or laundering clothing.

Eye Protection Wear safety glasses or goggles to protect against exposure.

Other Precautions None known.

9. Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State: Powder
Odor: Mild earthy
Color Various
Odor Threshold: No information available

Property Remarks/ - Method	Values
pH:	8-10
Freezing Point / Range	No data available
Melting Point / Range	No data available
Boiling Point / Range	No data available
Flash Point	No data available
Flammability (solid, gas)	No data available
Upper flammability limit	No data available
Lower flammability limit	No data available
Evaporation rate	No data available
Vapor Pressure	No data available
Vapor Density	No data available
Specific Gravity	2.6
Water Solubility	Partly soluble
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

VOC Content (%) No data available

10. Stability and Reactivity

10.1. Reactivity
Not expected to be reactive.

10.2. Chemical stability
Stable

10.3. Possibility of hazardous reactions
Will Not Occur

10.4. Conditions to avoid
None anticipated

10.5. Incompatible materials
Hydrofluoric acid.

10.6. Hazardous decomposition products
Amorphous silica may transform at elevated temperatures to tridymite (870 C) or cristobalite (1470 C).

11. Toxicological Information

11.1 Information on likely routes of exposure

Principle Route of Exposure Eye or skin contact, inhalation.

11.2 Symptoms related to the physical, chemical and toxicological characteristics

Acute Toxicity

Inhalation Inhaled crystalline silica in the form of quartz or cristobalite from occupational sources is carcinogenic to humans (IARC, Group 1). There is sufficient evidence in experimental animals for the carcinogenicity of tridymite (IARC, Group 2A).

Breathing silica dust may cause irritation of the nose, throat, and respiratory passages. Breathing silica dust may not cause noticeable injury or illness even though permanent lung damage may be occurring. Inhalation of dust may also have serious chronic health effects (See "Chronic Effects/Carcinogenicity" subsection below).

Eye Contact May cause mechanical irritation to eye.

Skin Contact None known.

Ingestion None known.

Chronic Effects/Carcinogenicity Silicosis: Excessive inhalation of respirable crystalline silica dust may cause a progressive, disabling, and sometimes-fatal lung disease called silicosis. Symptoms include cough, shortness of breath, wheezing, non-specific chest illness, and reduced pulmonary function. This disease is exacerbated by smoking. Individuals with silicosis are predisposed to develop tuberculosis.

Cancer Status: The International Agency for Research on Cancer (IARC) has determined that crystalline silica inhaled in the form of quartz or cristobalite from occupational sources can cause lung cancer in humans (Group 1 - carcinogenic to humans) and has determined that there is sufficient evidence in experimental animals for the carcinogenicity of tridymite (Group 2A - possible carcinogen to humans). Refer to IARC Monograph 68, Silica, Some Silicates and Organic Fibres (June 1997) in conjunction with the use of these minerals. The National Toxicology

Program classifies respirable crystalline silica as "Known to be a human carcinogen". Refer to the 9th Report on Carcinogens (2000). The American Conference of Governmental Industrial Hygienists (ACGIH) classifies crystalline silica, quartz, as a suspected human carcinogen (A2). There is some evidence that breathing respirable crystalline silica or the disease silicosis is associated with an increased incidence of significant disease endpoints such as scleroderma (an immune system disorder manifested by scarring of the lungs, skin, and other internal organs) and kidney disease.

This product contains Wyoming bentonite or other sorptive clays. Crystalline silica forms found in this particular clay are limited to quartz. Extreme temperatures that can generate cristobalite or tridymite are not expected to occur under realistic conditions. In addition, all quartz found in sorptive clays are considered "occluded", i.e., strongly coated with an amorphous silica surface (Wendlandt et al., 2007; Hochella and Muryama, 2010; SMI, 2014). Occluded quartz has been experimentally-determined to be relatively non-toxic compared to unoccluded quartz (Geh et al., 2006; Creutzenberg et al., 2008). A lack of health effects found in several studies examining occupational exposure to sorptive clays also suggest that chronic inhalation of sorptive clays is not expected to result in silicosis or cancer (Waxweiler et al., 1988; ACGIH, 1991; USEPA, 1996; IARC, 2005). In light of these findings OSHA has recently exempted Wyoming bentonite and other sorptive clays from the crystalline silica PEL in §1910.1053(a)(1)(iii).

11.3 Toxicity data

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Crystalline silica, quartz	14808-60-7	> 15000 mg/kg (human)	No data available	No data available

Substances	CAS Number	Skin corrosion/irritation
Crystalline silica, quartz	14808-60-7	Non-irritating to the skin

Substances	CAS Number	Serious eye damage/irritation
Crystalline silica, quartz	14808-60-7	Non-irritating to the eye

Substances	CAS Number	Skin Sensitization
Crystalline silica, quartz	14808-60-7	No information available.

Substances	CAS Number	Respiratory Sensitization
Crystalline silica, quartz	14808-60-7	No information available

Substances	CAS Number	Mutagenic Effects
Crystalline silica, quartz	14808-60-7	Not regarded as mutagenic.

Substances	CAS Number	Carcinogenic Effects
Crystalline silica, quartz	14808-60-7	Contains crystalline silica which may cause silicosis, a delayed and progressive lung disease. The IARC and NTP have determined there is sufficient evidence in humans of the carcinogenicity of crystalline silica with repeated respiratory exposure.

Substances	CAS Number	Reproductive toxicity
Crystalline silica, quartz	14808-60-7	No information available

Substances	CAS Number	STOT - single exposure
Crystalline silica, quartz	14808-60-7	No significant toxicity observed in animal studies at concentration requiring classification.

Substances	CAS Number	STOT - repeated exposure
Crystalline silica, quartz	14808-60-7	Causes damage to organs through prolonged or repeated exposure if inhaled: (Lungs)

Substances	CAS Number	Aspiration hazard
Crystalline silica, quartz	14808-60-7	Not applicable

12. Ecological Information

12.1. Toxicity

Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Crystalline silica, quartz	14808-60-7	EC50 (72 h) =440 mg/L (Selenastrum capricornutum)(similar substance)	LL0 (96 h) =10000 mg/L (Danio rerio)(similar substance)	No information available	LL50 (24 h) >10000 mg/L (Daphnia magna)(similar substance)

12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Crystalline silica, quartz	14808-60-7	The methods for determining biodegradability are not applicable to inorganic substances.

12.3. Bioaccumulative potential

Substances	CAS Number	Log Pow
Crystalline silica, quartz	14808-60-7	No information available

12.4. Mobility in soil

Substances	CAS Number	Mobility
Crystalline silica, quartz	14808-60-7	No information available

12.5 Other adverse effects

No information available

13. Disposal Considerations

13.1. Waste treatment methods

Disposal methods If practical, recover and reclaim, recycle, or reuse by the guidelines of an approved local reuse program. Should contaminated product become a waste, dispose of in a licensed industrial landfill according to federal, state, and local regulations.

Contaminated Packaging Follow all applicable national or local regulations.

14. Transport Information

US DOT

UN Number Not restricted
UN proper shipping name: Not restricted
Transport Hazard Class(es): Not applicable
Packing Group: Not applicable
Environmental Hazards: Not applicable

Canadian TDG

UN Number Not restricted
UN proper shipping name: Not restricted
Transport Hazard Class(es): Not applicable
Packing Group: Not applicable
Environmental Hazards: Not applicable

IMDG/IMO

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

IATA/ICAO

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code Not applicable
Special Precautions for User None

15. Regulatory Information

US Regulations

US TSCA Inventory All components listed on inventory or are exempt.

TSCA Significant New Use Rules - S5A2

Substances	CAS Number	TSCA Significant New Use Rules - S5A2
Crystalline silica, quartz	14808-60-7	Not applicable

EPA SARA Title III Extremely Hazardous Substances

Substances	CAS Number	EPA SARA Title III Extremely Hazardous Substances
Crystalline silica, quartz	14808-60-7	Not applicable

EPA SARA (311,312) Hazard Class
Chronic Health Hazard

EPA SARA (313) Chemicals

Substances	CAS Number	Toxic Release Inventory (TRI) - Group I	Toxic Release Inventory (TRI) - Group II
Crystalline silica, quartz	14808-60-7	Not applicable	Not applicable

EPA CERCLA/Superfund Reportable Spill Quantity

Substances	CAS Number	CERCLA RQ
Crystalline silica, quartz	14808-60-7	Not applicable

EPA RCRA Hazardous Waste Classification
If product becomes a waste, it does NOT meet the criteria of a hazardous waste as defined by the US EPA.

California Proposition 65

Substances	CAS Number	California Proposition 65
Crystalline silica, quartz	14808-60-7	carcinogen

U.S. State Right-to-Know Regulations

Substances	CAS Number	MA Right-to-Know Law	NJ Right-to-Know Law	PA Right-to-Know Law
Crystalline silica, quartz	14808-60-7	Carcinogen Extraordinarily hazardous	1660	Present

NFPA Ratings: Health 0, Flammability 0, Reactivity 0
HMIS Ratings: Health 0*, Flammability 0, Physical Hazard 0 , PPE: E

Canadian Regulations

Canadian Domestic Substances List (DSL) All components listed on inventory or are exempt.

16. Other information

Preparation Information

Prepared By
Chemical Stewardship
Telephone: 1-281-871-6107
e-mail: fdunexchem@halliburton.com

Revision Date: 14-Aug-2017

Reason for Revision SDS sections updated:
2
8
11

Additional information
For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

Key or legend to abbreviations and acronyms used in the safety data sheet
bw – body weight
CAS – Chemical Abstracts Service
d - day
EC50 – Effective Concentration 50%
ErC50 – Effective Concentration growth rate 50%
h - hour
LC50 – Lethal Concentration 50%
LD50 – Lethal Dose 50%
LL50 – Lethal Loading 50%
mg/kg – milligram/kilogram
mg/L – milligram/liter
mg/m^3 - milligram/cubic meter
mm - millimeter
mmHg - millimeter mercury
NIOSH – National Institute for Occupational Safety and Health
NTP – National Toxicology Program
OEL – Occupational Exposure Limit
PEL – Permissible Exposure Limit
ppm – parts per million
STEL – Short Term Exposure Limit
TWA – Time-Weighted Average
UN – United Nations
w/w - weight/weight

Key literature references and sources for data
www.ChemADVISOR.com/

Disclaimer Statement
This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The

information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

End of Safety Data Sheet

Soda Ash

Alkalinity Agent

Description

Soda Ash alkalinity agent is a granular powder form of sodium carbonate primarily used to condition and soften make-up water and to raise pH.

Applications/Functions

- Treat out calcium hardness in make-up water
- Raise pH

Advantages

- Can eliminate calcium ions by converting to insoluble carbonate
- Can maximize the performance of bentonite and polymer products

Typical Properties

Appearance	Variable-colored powder (white to gray)
pH of 5% solution	11.5
Bulk density, lb/ft^3	57-65

Recommended Treatment

- Hardness and pH levels of make-up water should be checked prior to addition of Soda Ash.
- When treating make-up water, pH ranges should be maintained between 8.5 – 9.5
- Addition of Soda Ash should always be done prior to addition of bentonite or polymer to the fluid system.
- Soda Ash alkalinity agent should not be added at the same time as other drilling fluid components.

General Treatment:

- 1-2 pounds of Soda Ash alkalinity agent per 100 gallons of make-up water or 1.2-2.4 kilograms per cubic meter of make-up water.
- Use as required to remove calcium ions but do not add in excess as overtreatment can lead to detrimental effects and reduced performance of the drilling fluid components and/or system.
- Mix slowly through a jet mixer or sift slowly into the vortex of a high-speed stirrer.

Rev. 08/18/2011

Packaging	Soda Ash is packaged in 50-lb (22.7 kg) or 100-lb (45.4 kg) multiwall paper bags.
Availability	Soda Ash can be purchased through any Baroid Industrial Drilling Products Retailer. To locate the Baroid IDP retailer nearest you contact the Customer Service Department in Houston or your area IDP Sales Representative.

Baroid Industrial Drilling Products
Product Service Line, Halliburton
3000 N. Sam Houston Pkwy. E.
Houston, TX 77032

Customer Service	(800) 735-6075 Toll Free	(281) 871-4612
Technical Service	(877) 379-7412 Toll Free	(281) 871-4613

HALLIBURTON

SAFETY DATA SHEET

Product Trade Name: **SODA ASH**

Revision Date: 24-Apr-2017 **Revision Number:** 42

1. Identification

1.1. Product Identifier

Product Trade Name: SODA ASH
Synonyms None
Chemical Family: Carbonate
Internal ID Code HM001822

1.2 Recommended use and restrictions on use

Application: Buffer
Uses advised against No information available

1.3 Manufacturer's Name and Contact Details

Manufacturer/Supplier

Halliburton Energy Services, Inc.
P.O. Box 1431
Duncan, Oklahoma 73536-0431
Telephone: 1-281-871-6107

Halliburton Energy Services, Inc.
645 - 7th Ave SW Suite 1800
Calgary, AB
T2P 4G8
Canada

Prepared By Chemical Stewardship
Telephone: 1-281-871-6107
e-mail: fdunexchem@halliburton.com

1.4. Emergency telephone number

Emergency Telephone Number: 1-866-519-4752 or 1-760-476-3962
Global Incident Response Access Code: 334305
Contract Number: 14012

2. Hazards Identification

2.1 Classification in accordance with paragraph (d) of §1910.1200

Serious Eye Damage/Irritation	Category 2 - H319

2.2. Label Elements

Hazard Pictograms

Signal Word: Warning

Hazard Statements H319 - Causes serious eye irritation

Precautionary Statements

Prevention P264 - Wash face, hands and any exposed skin thoroughly after handling
P280 - Wear eye protection/face protection

Response P305 + P351 + P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P337 + P313 - If eye irritation persists: Get medical advice/attention

Storage None

Disposal None

2.3 Hazards not otherwise classified

None known

3. Composition/information on Ingredients

Substances	CAS Number	PERCENT (w/w)	GHS Classification - US
Sodium carbonate	497-19-8	60 - 100%	Eye Irrit. 2 (H319)

The exact percentage (concentration) of the composition has been withheld as proprietary.

4. First Aid Measures

4.1. Description of first aid measures

Inhalation If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Eyes In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.

Skin Wash with soap and water. Get medical attention if irritation persists.

Ingestion Do NOT induce vomiting. Give nothing by mouth. Obtain immediate medical attention.

4.2 Most important symptoms/effects, acute and delayed

Causes eye irritation

4.3. Indication of any immediate medical attention and special treatment needed

Notes to Physician Treat symptomatically.

5. Fire-fighting measures

5.1. Extinguishing media

Suitable Extinguishing Media

Water fog, carbon dioxide, foam, dry chemical.

Extinguishing media which must not be used for safety reasons

None known.

5.2 Specific hazards arising from the substance or mixture

Special exposure hazards in a fire
Decomposition in fire may produce harmful gases.

5.3 Special protective equipment and precautions for fire-fighters

Special protective equipment for firefighters
Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

6. Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Use appropriate protective equipment. Avoid creating and breathing dust. Avoid contact with skin, eyes and clothing. Ensure adequate ventilation.
See Section 8 for additional information

6.2. Environmental precautions

Prevent from entering sewers, waterways, or low areas.

6.3. Methods and material for containment and cleaning up

Scoop up and remove.

7. Handling and storage

7.1. Precautions for safe handling

Handling Precautions
Avoid contact with eyes, skin, or clothing. Avoid creating or inhaling dust. Ensure adequate ventilation. Wash hands after use. Launder contaminated clothing before reuse. Use appropriate protective equipment.
Hygiene Measures
Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities

Storage Information
Store away from acids. Store in a cool, dry location. Product has a shelf life of 60 months.

8. Exposure Controls/Personal Protection

8.1 Occupational Exposure Limits

Substances	CAS Number	OSHA PEL-TWA	ACGIH TLV-TWA
Sodium carbonate	497-19-8	Not applicable	Not applicable

8.2 Appropriate engineering controls

Engineering Controls Use in a well ventilated area. Localized ventilation should be used to control dust levels.

8.3 Individual protection measures, such as personal protective equipment

Personal Protective Equipment If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

Respiratory Protection If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective

equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional.

Hand Protection	Normal work gloves.
Skin Protection	Normal work coveralls.
Eye Protection	Dust proof goggles.
Other Precautions	None known.

9. Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State:	Powder	**Color**	White
Odor:	Odorless	**Odor Threshold:**	No information available

Property Remarks/ - Method	Values
pH:	11.5
Freezing Point / Range	No data available
Melting Point / Range	851 °C
Boiling Point / Range	No data available
Flash Point	No data available
Flammability (solid, gas)	No data available
Upper flammability limit	No data available
Lower flammability limit	No data available
Evaporation rate	No data available
Vapor Pressure	No data available
Vapor Density	No data available
Specific Gravity	2.5
Water Solubility	Partly soluble
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

Molecular Weight	105.99 g/mole
VOC Content (%)	No data available

10. Stability and Reactivity

10.1. Reactivity
Not expected to be reactive.

10.2. Chemical stability
Stable

10.3. Possibility of hazardous reactions
Will Not Occur

10.4. Conditions to avoid
None anticipated

10.5. Incompatible materials

Strong acids.

10.6. Hazardous decomposition products

Carbon monoxide and carbon dioxide.

11. Toxicological Information

11.1 Information on likely routes of exposure

Principle Route of Exposure Eye or skin contact, inhalation.

11.2 Symptoms related to the physical, chemical and toxicological characteristics

Acute Toxicity

Inhalation May cause mild respiratory irritation.

Eye Contact Causes eye irritation.

Skin Contact Not irritating to skin in rabbits.

Ingestion Irritation of the mouth, throat, and stomach.

Chronic Effects/Carcinogenicity No data available to indicate product or components present at greater than 0.1% are chronic health hazards.

11.3 Toxicity data

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Sodium carbonate	497-19-8	4090 mg/kg (Rat) 2800 mg/kg (Rat)	2210 mg/kg (Mouse) > 2000 mg/kg (Rabbit)	2.3 mg/L (Rat) 2h

Substances	CAS Number	Skin corrosion/irritation
Sodium carbonate	497-19-8	Non-irritating to the skin

Substances	CAS Number	Serious eye damage/irritation
Sodium carbonate	497-19-8	Irritating to eyes

Substances	CAS Number	Skin Sensitization
Sodium carbonate	497-19-8	Not classified

Substances	CAS Number	Respiratory Sensitization
Sodium carbonate	497-19-8	No information available

Substances	CAS Number	Mutagenic Effects
Sodium carbonate	497-19-8	In vivo tests did not show mutagenic effects.

Substances	CAS Number	Carcinogenic Effects
Sodium carbonate	497-19-8	No information available

Substances	CAS Number	Reproductive toxicity
Sodium carbonate	497-19-8	Did not show teratogenic effects in animal experiments.

Substances	CAS Number	STOT - single exposure
Sodium carbonate	497-19-8	No significant toxicity observed in animal studies at concentration requiring classification.

Substances	CAS Number	STOT - repeated exposure
Sodium carbonate	497-19-8	No significant toxicity observed in animal studies at concentration requiring classification.

Substances	CAS Number	Aspiration hazard
Sodium carbonate	497-19-8	Not applicable

12. Ecological Information

12.1. Toxicity

Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Sodium carbonate	497-19-8	EC50 242 mg/L (Nitzschia)	TLM24 385 mg/L (Lepomis macrochirus) LC50 310-1220 mg/L (Pimephales promelas) LC50 (96h) 300 mg/L (Lepomis macrochirus)	No information available	EC50 265 mg/L (Daphnia magna) EC50 (48h) 200 – 227 mg/L (Ceriodaphnia sp.)

12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Sodium carbonate	497-19-8	The methods for determining biodegradability are not applicable to inorganic substances.

12.3. Bioaccumulative potential

Substances	CAS Number	Log Pow
Sodium carbonate	497-19-8	No information available

12.4. Mobility in soil

Substances	CAS Number	Mobility
Sodium carbonate	497-19-8	No information available

12.5 Other adverse effects

No information available

13. Disposal Considerations

13.1. Waste treatment methods

Disposal methods Bury in a licensed landfill according to federal, state, and local regulations.
Contaminated Packaging Follow all applicable national or local regulations.

14. Transport Information

US DOT

UN Number Not restricted
UN proper shipping name: Not restricted
Transport Hazard Class(es): Not applicable
Packing Group: Not applicable
Environmental Hazards: Not applicable

Canadian TDG

UN Number Not restricted
UN proper shipping name: Not restricted
Transport Hazard Class(es): Not applicable
Packing Group: Not applicable
Environmental Hazards: Not applicable

IMDG/IMO

UN Number Not restricted
UN proper shipping name: Not restricted
Transport Hazard Class(es): Not applicable

Packing Group: Not applicable
Environmental Hazards: Not applicable

IATA/ICAO

UN Number Not restricted
UN proper shipping name: Not restricted
Transport Hazard Class(es): Not applicable
Packing Group: Not applicable
Environmental Hazards: Not applicable

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code Not applicable
Special Precautions for User None

15. Regulatory Information

US Regulations

US TSCA Inventory All components listed on inventory or are exempt.

TSCA Significant New Use Rules - S5A2

Substances	CAS Number	TSCA Significant New Use Rules - S5A2
Sodium carbonate	497-19-8	Not applicable

EPA SARA Title III Extremely Hazardous Substances

Substances	CAS Number	EPA SARA Title III Extremely Hazardous Substances
Sodium carbonate	497-19-8	Not applicable

EPA SARA (311,312) Hazard Class
Acute Health Hazard

EPA SARA (313) Chemicals

Substances	CAS Number	Toxic Release Inventory (TRI) - Group I	Toxic Release Inventory (TRI) - Group II
Sodium carbonate	497-19-8	Not applicable	Not applicable

EPA CERCLA/Superfund Reportable Spill Quantity

Substances	CAS Number	CERCLA RQ
Sodium carbonate	497-19-8	Not applicable

EPA RCRA Hazardous Waste Classification
If product becomes a waste, it does NOT meet the criteria of a hazardous waste as defined by the US EPA.

California Proposition 65

Substances	CAS Number	California Proposition 65
Sodium carbonate	497-19-8	Not applicable

U.S. State Right-to-Know Regulations

Substances	CAS Number	MA Right-to-Know Law	NJ Right-to-Know Law	PA Right-to-Know Law
Sodium carbonate	497-19-8	Not applicable	Not applicable	Not applicable

NFPA Ratings: Health 2, Flammability 0, Reactivity 0
HMIS Ratings: Health 2, Flammability 0, Physical Hazard 0 , PPE: B

Canadian Regulations

Canadian Domestic Substances List (DSL) All components listed on inventory or are exempt.

16. Other information

Preparation Information

Prepared By
Chemical Stewardship
Telephone: 1-281-871-6107
e-mail: fdunexchem@halliburton.com

Revision Date: 24-Apr-2017

Reason for Revision SDS sections updated:
2

Additional information
For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

Key or legend to abbreviations and acronyms used in the safety data sheet
bw – body weight
CAS – Chemical Abstracts Service
d - day
EC50 – Effective Concentration 50%
ErC50 – Effective Concentration growth rate 50%
h - hour
LC50 – Lethal Concentration 50%
LD50 – Lethal Dose 50%
LL50 – Lethal Loading 50%
mg/kg – milligram/kilogram
mg/L – milligram/liter
mg/m^3 - milligram/cubic meter
mm - millimeter
mmHg - millimeter mercury
NIOSH – National Institute for Occupational Safety and Health
NTP – National Toxicology Program
OEL – Occupational Exposure Limit
PEL – Permissible Exposure Limit
ppm – parts per million
STEL – Short Term Exposure Limit
TWA – Time-Weighted Average
UN – United Nations
w/w - weight/weight

Key literature references and sources for data
www.ChemADVISOR.com/

Disclaimer Statement
This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

End of Safety Data Sheet

Appendix Q– Diving Procedures and Safe Practices Manual

DIVING PROCEDURES & SAFE PRACTICES MANUAL

REVISION TABLE			
REV. #	**DESCRIPTION**	**DATE**	**APPROVED**
00	Creation	06/20/08	AB AG
01	Revised after review	10/17/17	LA DC
02	Revised after revew	12/17/21	LA EP DC
03	Revised after reveiw	05/18/22	LA EP DC
04	Revised after reveiw	06/17/22	LA EP

*This manual references the current 29 CFR 1910 standards for Commercial Diving Operations and the US Navy Diver's Handbook – Revision 7

1. General Information

1.1 Introduction

The procedures and requirements outlined in this manual are founded on the regulations that have been established by the U. S. Coast Guard, the Association of Diving Contractors (ADC), and the Occupational Safety and Health Administration (OSHA), and the US Navy Diver's Handbook – Revision 7

When diving operations occur that are not covered in this manual, local regulations must be determined. Should differences between local regulations and this manual occur the more conservative guidance shall be used. If a direct conflict exists between this manual and local regulations, Caldwell Marine International *(CMI*) management must be consulted for guidance.

This manual applies to all types of diving operations conducted by *Caldwell Marine International* divers and contractors. It provides guidance and detailed procedures to be followed when conducting air diving, both surface supplied and SCUBA. As changes to regulations governing commercial diving occur this manual will be updated

1.2. Diving Personnel Responsibilities

Each dive team member shall have the experience or training necessary to perform assigned tasks in a safe and healthful manner. All dive team members shall be trained in cardiopulmonary resuscitation and first aid (American Red Cross standard course or equivalent) and in the use of a manual bag-type resuscitator. Dive team members who are exposed to or control the exposure of others to hyperbaric conditions shall be trained in diving-related physics and physiology and fully understand emergency procedures.

1.2.1 Diving Supervisor

The Diving Supervisor is the on-scene-representative of *Caldwell Marine International* management and is directly responsible for the safe conduct of all phases of diving operations. The diving supervisor shall be designated in writing and given to the Person-in-Charge prior to any diving operation**. THE NUMBER ONE PRIORITY OF THE DIVING SUPERVISOR IS THE SAFETY OF THE DIVE TEAM UNDER THEIR AUTHORITY.** The Diving Supervisor has the final word concerning diving operations, shall exercise caution when dealing with matters not covered by company policy, and must understand and comply with all government regulations and company policies that apply to the diving operation.

The responsibilities of the Diving Supervisor include:

- The Supervisor shall be in immediate control of the diving operation and available to implement emergency procedures.
- The Supervisor is not permitted to dive unless there is another qualified supervisor designated in writing and is available to take over the divingoperation.
- The Diving Supervisor shall coordinate with the Person-in-Charge, Craft Masters, Customer Representative, all persons responsible for any thing that may affect the safety of the divers and the efficient completion of the divingoperation.
- Personally verify that all personnel in the dive team are qualified and physically able to perform tasks assigned. He must make an assessment of the physical condition of the divers prior to each dive to determine if any physical impairment is present which would be harmful to their health and safety ether in the water or in a chamber.
- The Diving Supervisor will perform Job Hazard Analysis (JHA) for each task undertaken.
- The supervisor will establish a dive plan ensuring that enough trained personnel, supplies, and proper equipment are available for the safe and timely completion of the diving operation.
- The Diving supervisor shall personally verify the emergency assistance checklist to ensure a two-way communication system is available to reach emergency assistance if required.
- The Diving supervisor shall ensure that diving operations are conducted from a safe dive platform.
- The Supervisor shall verify that the Safety Procedures Checklist, Equipment Procedures Checklist, and the Recompression Chamber Checklist, if chamber is on location, have been performed properly and ensure that all diving equipment designated for use is suitable for the planned operation and is in good working order.
- Ensure that all manuals, instructions, decompression and recompression tables and regulatory publications are available at the dive location. Provide the Customer Representative a copy of the dive manual and a dive plan outlining the diving operation.
- The Diving Supervisor shall brief the dive team on the details to the task, safety precautions and emergency procedures. After the dive he will assess the diver condition and instruct to report any physical problems that may occur as soon as possible.
- The Diving Supervisor will immediately activate emergency procedures at the first sign of a problem with the dive. As soon as the situation stabilizes he will inform the Person-in-Charge, and Customer Representative.
- Report all accidents or incidents required by law to the company. Insure that all reports required are promptly filled out sent to the proper authorities.

1.2.2 Diver

Assigned by the Diving Supervisor, the diver should be at least 18 years old, and medically certified "fit to dive". The diver shall be qualified to dive the equipment in use, and be in possession of an up to date diver's logbook. The Diver must have a current certification in First Aid and CPR.

- Understand and comply with company policies and this document.
- Follow safe diving practice at all times.
- Ensure diver-worn equipment is properly maintained, complete, and ready for use. Asrequired, assist in the maintenance and repair of all diving equipment.
- Immediately obey all commands or instructions form the diving supervisor to return the surface or first decompression stop.
- Act as standby diver when directed to do so.
- Act as a chamber operator as required.
- Report any recent medical treatment or illness to the diving supervisor.
- Report all symptoms after a dive to the diving supervisor immediately and as accurately as possible.
- Report all equipment problems to the diving supervisor.
- Know and observe the rules for flying after diving or traveling to altitudes higher than the dive site.
- Remain in the vicinity of the recompression chamber if required.
- Be ready to assume the responsibilities of the Diving Supervisor where one is not required.

1.2.3 Standby Diver

The Standby Diver is that individual possessing the required training and experience to enter the water at the diving station in order to render assistance to a stricken diver.

- The Standby's helmet or mask will be fitted to the standby umbilical in a wrench tight status. The flow to the helmet or mask will be verified, and a communications check will be conducted to ensure three-way communications between the standby diver, topside, and the stricken diver.
- The Standby will remain in the immediate vicinity of the diving control station, receives the same briefings and instructions as the working diver, monitors the progress of the dive, and be fully prepared to respond if called upon for assistance i.e.. Standby diver is at the dive station with his diving helmet, harness, bail-out bottle and weight belt and available to render immediate assistance when called apon.The standby diver shall also be equipped with an octopus rig.

1.2.4 Tender

The tender is assigned by the diving supervisor to continuously tend a diver. He must have a basic understanding of diving acquired through a special school or equivalent experience He shall not be assigned any other task while the diver is under the water. The Tender must have a current certification in First Aid and CPR. The Tender must:

- Set up and operate all equipment as directed by the lead tender, Diving supervisor.

Assist in topside work connected with the diving operations or other topside work as required or directed.

- Stay alert to what is going on with the dive. Be aware of the divers location and the

divers depth. Once the diver is in the water, the tender constantly tends the lines to eliminate excess slack or tension. The tender exchanges line-pull signals with the diver, keeps the Diving Supervisor informed of the line-pull signals and amount of diving hose/tending line over the side and remains alert for any signs of an emergency.

- Immediately report any conditions, which may be hazardous or unsafe.
- If qualified, operate the recompression chamber when directed by the diving supervisor.
- If qualified to act as an inside tender he must be medically certified, "fit to dive."
- If acting as an inside tender he must be familiar with and alert for any symptoms of oxygen toxicity.

1.3 Medical Requirements

1.3.1 General

For persons engaged as divers or otherwise subjected to hyperbaric conditions the following medical examinations are required.

- An initial medical examination
- Periodic re-examination recommended annually but as minimum on an annual basis.

1. A re-examination is required after a diving related injury or illness to determine fitness to return to diving duty. For the purposes of these medical requirements all examinations are to be performed only by licensed physicians qualified to perform commercial diver medical examinations. Must have licensed physician signature to be legible and/or stamped, with their medigal designation clearly indicated. Non-physicians are not recognized by the ADCI as being qualified to perform commercial diver medical examinations

1.3.2 Physical Examination

The initial examination and subsequent periodic re-examination include the following:

- Work History
- The test required in table 1-1
- Any test deemed necessary to establish the presence of any disqualifying conditions
- Any test the physician needs to prepare the written report.

If with in one year the individual has had a comprehensive medical examination comparable to the initial diving physical and no disqualifying conditions are present, the examination can be use in place of the initial examination.

1.3.3 Re-examination After Diving Injury or Illness

Any person exposed to hyperbaric conditions who has a diving related injury or illness that requires hospitalization of more 72 hours or known AGE or decompression sickness with central nervous system dysfunction will require a re-examination and be released by a qualified physician before they can return to diving duty.
The examining physician should determine the scope of the examination in light of the nature of the diving injury or illness.

1.3.4 Physician's Written Report

With respect to the initial examination or any re-examination, the diver must obtain a written report from the examining physician that contains the following information:

- Results of the examination and tests given on accordance with this section.
- The physician's opinion as to the fitness of the person to perform as a diver based on his medical history and the results of the test required in table 1-1 in particular to the following:
- Stress to the pulmonary, muscular, cardiac and skeletal systems.
- Interference with effective external communication of the gas-containing organs of the body.
- Condition if the central and peripheral nervous system.
- Any other factor that indicates material impairment of the employee's health.
- The physician's opinion as to whether there exist any disqualifying conditions.
- Any recommended limitations placed on the persons activities as a diver or exposure to hyperbaric conditions.
- A statement by the examining physician the individual has been informed of the results of the physical any and conditions that require further examination or treatment.

1.3.5 Disqualifying Conditions

A person having any of the following conditions, as determined by a qualified physician shall be disqualified from engaging in diving or other hyperbaric activities:

- History of seizure disorders other than childhood febrile convulsions.
- Cystic or cavity disease of the lungs, significant obstructive or restrictive lung disease, or recurrent pneumothorax.
- Chronic inability to equalize sinus and middle ear cavities.
- Significant central peripheral nervous system disease.
- Significant cardiac abnormalities.
- Chronic alcoholism, drug abuse, or history of psychosis.
- Significant hemoglobinopathies.
- Significant malignancies.
- Grossly impaired hearing.
- Pregnancy.
- Chronic obstruction of the Eustachian tubes.
- Chronic gastrointestinal disease.
- Hernia
- Severe head injury, cranial surgery.

- Severe visual defects.
- Excessive obesity.
- Diabetes.
- Gross abnormality of the renal tract.
- Severe Stammering.
- Any acute condition while undergoing treatment for that condition

Below are the current Disqualifying Conditions Listed on the ADCI current edition:

- History of seizure disorder other than early childhood febrile conditions.
- Cystic, bullous or cavitary disease of the lungs, significant obstructive or restrictive lung disease and/or spontaneous pneumothorax.
- Chronic inability to equalize sinus and middle ear pressure.
- Significant central or peripheral nervous system disease or impairment.
- Chronic alcoholism, drug abuse or dependence or history of psychosis.
- Hemoglobinpathies associated with comorbidities.
- Any person engaged as a diver, or otherwise exposed to hyperbaric conditions, will have a medical evaluation following any non-diving injury or illness that requires any prescription medication, any surgical procedure or any hospitalization.
- Untreated or persistent/metastatic or other significant malignancies including those that require chemotherapy and/or radiation therapy unless five years after treatment with no evidence of recurrence.
- Hearing impairment in the better ear should be at least 40 dB average in the 500, 1000, and 2000 Hz frequencies.
- Justa-articular osteonecrosis is disqualifying. Chronic conditions requiring continuous control by medication that increases risks in diving.
- Pregnancy.

The above current list does not mean that all other conditions are acceptable such as excessive obesity. For example previously listed diabetes. Current gudielines suggest that DM with a stable HBA1c and no medications is not disqualifying.

1.3.6 Withdrawal from Hyperbaric Conditions

Withdrawal from hyperbaric conditions shall be determined by a physician examination whether a person's health will be at risk by continued hyperbaric exposure.

1.3.7 Medical Record Keeping

An accurate medical record for each person subject to the medical specifications of this section should be maintained. The record should include the employees current dive physical and be maintained for at least 5 years after the last hyperbaric exposure.

Medical Test for Diving			
Test	**Initial**	**Annual Per ADCI current table 2.3.4 tble 1**	**Comments**
History and Physical	X	X	Include predisposition to unconsciousness, vomiting cardiac arrest, impairment of oxygen transport, serious blood loss, or anything that in the opinion of the examining physician will interfere with effective underwater work.
Chest X-Ray	X	X	PA (Projection: 14" x 17" min.)
Bone and Joint X-Ray Survey	X		Required initially and as medically indicated.
EKG: Stress			Required only as medically indicated.
Pulmonary Function	X	X	Required initially and as medically indicated
Audiogram	X	X	Threshold audiogram by pure tone audiometry; bone conduction audiogram as medically indicated.
Visual Acuity	X	X	Required initially and as medically indicated.
Color Blindness	X		Required initially
Hematocrit, Hemoglobin, WBC Count	X	X	
EEG			Required only as medically indicated
Routine Urinalysis	X	X	
EKG Standard (12l)	X		Required initially to establish baseline, annually after age 35, and as medically indicated
Comprehensive Metabolic profile.	X	X	Optional including cholesteraol and triglucerides required for diversd over 40
Lipid Panel	X	X	Required annualy afterage 35
Framingham Risk Score	X	X	Required annualy after age of 35

1.4 Record Keeping

1.4.1 Diving Logs

During each diving operation, an operation log shall be maintained covering the entire operation. The Diving Supervisor will ensure that the master operations log is properly updated.

Operations logbook will be maintain at the dive control center. This logbook will be a chronological record of all events that directly affect the diving operation. The diving supervisor will sign all entries. The logbook shall include the following:

- Date, time, and location at the start and completion of each dive operation.
- Approximate underwater and surface conditions (weather, visibility, temperatures, and currents).
- Names of dive team members including diving supervisor.
- General nature of work performed.
- Repetitive dive designation or elapsed time since last hyperbaric exposure if less than 24 hours for each diver.
- Diving modes used.
- Maximum depth and bottom time for each diver.
- Name of person-in-charge
- For each dive outside the no-de-compression limits, deeper than 130 fsw, or using mixed-gas, the breathing gases and decompression table designations used.
- When decompression sickness or gas embolism is suspected or symptoms are evident:
- The name of the diver; and a description and results of treatment
- For each fatality or any diving related injury or illness that results in incapacitation of more than 72 hours or requires any dive team member to be hospitalized for more than 24 hours—The date, Time, Circumstances; and Extent of any injury or illness.
- The diving supervisor shall insure that the following is recorded in the logbook for each diving operation deviating from the requirements of this manual:
- A description of the circumstances leading to the situation.
- The deviations made.
- The corrective action taken, if appropriate, to reduce the possibility of recurrence.

1.4.2 Maintenance Logs

Caldwell Marine International shall insure that the equipment identified below will be maintained, inspected/tested, and tagged at the appropriate intervals and documented:

- The date and results of each check of the medical kits.
- The date and results of each test of the air compressor.
- The date and results of each check of breathing mixtures.
- The date and results of each check of each breathing supply system.
- The date, equipment cleaned, general cleaning procedure, and names of persons cleaning the diving equipment for oxygen service.
- The date and results of each test of the breathing supply hoses and sys-tem.

- The date and results of each inspection of the breathing gas supply system.
- The date and results of each test of depth gages and timekeeping de-vices.
- The date and results of each test and inspection of each PVHO.
- The date and results of each inspection of the diving equipment.
- The date and results of each test and inspection of pressure piping.
- The date and results of each test and inspection of volume tanks and cylinders. (see addendum 3-4)

1.5 Limits/Prohibitions

This section will establish limits for the use of the various types of diving equipment and breathing gases for *Caldwell Marine International* divers and contractors. These limits are in accordance with accepted safe diving practices. **THEY ARE CONSIDERED FIRM DO NOT EXCEED THEM WITHOUT EXPRESS PERMISSION FROM *Caldwell Marine International* MANAGEMENT**. The limits established in this section are to govern all diving operations regardless of the geographical location, unless they are in conflict with regulations established by the local government. In this case the limits that are more conservative shall be used, and the area of difference will be brought to the attention of *Caldwell Marine International* management.

1.5.1 General Limits

The limits presented in Table 1-2 are to govern all diving operations conducted by *Caldwell Marine International* divers and contractors.

Table 1-2 *Caldwell Marine International Diving* Limits

Depth: Feet	Meters	Type of Diving Activity
0 fsw	0 m	CMI requires a bail out bottle at all times regardless of depth. (USCG)
60 fsw	18.2 m	Recompression chamber required at the dive site for any dives deeper than this depth or any dives requiring decompression. (ADC)
130 fsw	39.6	Stage or open bell required for dives deeper than this depth or for any for any dives requiring decompression (USCG)
100 fsw	39.6	Maximum permissible depth for SCUBA (USCG)
170 fsw	51.8	Normal working limit for surface supplied air diving. Dives deeper than this depth will not be conducted without the permission of *Caldwell Marine International* management (*Caldwell Marine International*)
190 fsw	57.9 m	Air dives deeper than this depth will be limited to dives with a maximum bottom time of 30 minutes. (USCG)
220 fsw	67 m	Maximum limit for live boating. (USCG) – not permitted
220 fsw	67 m	Maximum limit for surface supplied air diving. Maximum bottom time – 30 minutes. (USCG)

2. Operation Planning

2.1 General Planning Considerations

Planning of a diving operation shall include a Job Hazard Analysis. A successful diving project is the direct outcome of careful, thorough planning. The nature of each operation determines the scope of the planning effort, but certain general considerations apply to every operation.

- **Bottom Time**: Bottom time is always at a premium. Developing measures to conserve bottom time or increase diver effectiveness is critical for success.
- **Preplanning:** An operation that is delayed due to unanticipated problems may fail. Preplanning the use of the time available to accomplish specific objectives is a prerequisite to success.
- **Equipment:** Selecting the correct equipment for the job is critical to success.
- **Environmental Conditions:** Diving operational planners must plan for safely mitigating extreme environmental conditions. Personnel and support facility safety shall be given the highest priority.
- **Diver Protection:** It is critical to protect divers from shipping hazards, temperature extremes, and dangerous pollution during all operations.
- **Emergency Assistance:** It is critical to coordinate emergency assistance from outside sources before the operation begins.
- **Weather:** Because diving operations are weather dependent, dive planning should factor in delays due to weather.

2.2 Define Project Objective

A clear and concise statement of the project objective shall be established. This includes an in-depth breakdown of all task required to complete the job, the location and the time frame in which it is to be accomplished. All parties involved in the project, diving and non-diving should work together to define the scope of work. Once the diving objectives have been outlined planning can begin.

2.3 Information Gathering

The size of the operation, the diving site location, bottom conditions, and the prevailing environmental conditions influence the extent and type of information that must be gathered when planning an operation. Some operations are of a recurring nature; so much of the required information is readily available. However, even for a standard operation, procedures may have been modified or special environmental conditions may exist, requiring a change in the plan or special tools. Potential changes in task requirements affecting work procedures should not be overlooked during planning. Areas, which should be considered when planning an operation, include government regulations affecting diving, resources, both logistical and emergency that are available locally to support the operation.

2.3.1 Surface Conditions

Surface conditions in the operating area affect both the divers and the topside team members. Surface conditions are influenced by location, time of year, wind, waves, tides, current, cloud cover, temperature, visibility, and the presence of other ships. Completing the Environmental Assessment Work-sheet can help ensure that environmental factors are not overlooked during planning. Weather reports and long-range weather forecasts shall be studied to determine if conditions will be acceptable for diving. Weather reports shall be continually monitored while an operation is in progress.

NOTE: Diving should be discontinued if sudden squalls, electrical storms, heavy seas, unusual tide or any other condition exists that, in the opinion of the Diving Supervisor, jeopardizes the safety of the divers or topside personnel.

2.3.2 Sea State

A significant factor is the sea state. Wave action can affect everything from the stability of the moor to the vulnerability of the crew to seasickness or injury. Unless properly moored, a ship or boat drifts or swings around an anchor, fouling lines and dragging divers. Wave action will cause the vessel to pitch and roll, resulting in a potentially hazardous surge on lines and hoses to the diver and equipment such as a jet sled or bell, on or near the bottom. Divers are not particularly affected by the action of surface waves unless operating in surf or shallow waters, or if the waves are exceptionally large. Surface waves may become a serious problem when the diver enters or leaves the water and during decompression stops near the surface.

2.3.3 Tender Safety

Effective dive planning shall provide for extreme temperatures that may be encountered on the surface. Normally, such conditions are a greater problem for tending personnel than for a diver. Any reduction in the effectiveness of the topside personnel may endanger the safety of a diver. Tending personnel shall guard against:

- Sunburn
- Windburn
- Hypothermia
- Frostbite
- Dehydration
- Heat exhaustion

2.3.4 Surface Visibility

Variations in surface visibility are important. Reduced visibility may seriously hinder or force postponement of diving operations. For operations to be conducted in a known fog belt, the diving schedule should allow for delays because of low visibility. Diver and support crew safety is the prime consideration when determining whether surface visibility is adequate. Proper flags signaling devices shall be use during the day and at the proper lighting shall be use to warn other vessels in the area.

2.3.5 Depth

Depth is a major factor in selecting both diving personnel and apparatus and influences the decompression profile for any dive. Depth must be carefully measured and plotted over the general area of the operation to get an accurate depth profile of the dive site. Operations in deep waters may also call for special support equipment such as underwater lights, cameras, ROV, etc.

2.3.6 River or Major Ocean Currents

The direction and velocity of normal river, ocean, and tidal currents will vary with time of the year, phase of the tide, con-figuration of the bottom, water depth, and weather. Tide and current tables show the conditions at the surface only and should be used with caution when planning diving operations. The direction and velocity of the current beneath the surface may be quite different than that observed on the surface.

2.3.7 Underwater Visibility

Underwater visibility varies with depth and turbidity. Visibility is poorest in harbor areas because of river silt, sewage, and industrial wastes flowing into the harbor. Agitation of the bottom caused by strong currents and the passage of large ships can also affect visibility. Divers are frequently required to dive at night or in an enclosed space where visibility very limited. Generally good visibility can be considered a luxury, and should be accounted for.

2.3.8 Type of Bottom

The type of bottom may have a significant effect upon a diver's ability to move and work efficiently and safely. Advance knowledge of bottom conditions is important in scheduling work, selecting dive technique and equipment, and anticipating possible hazards. The type of bottom is often noted on the chart for the area, but conditions can change within just a few feet.

2.4 Logistics

The initial task to be planned for is getting all equipment, supplies and personnel on site at the proper time. Once on the scene and operating the problem becomes one of maintaining an adequate supply required materials to meet anticipated requirements.

- Consultation with the Person-in-Charge of the platform from which operations are to be conducted is necessary. He must fully understand all of the demands that will be placed on his vessel so he has time to make the preparations required to ensure that his craft is ready on time. Arrangements must also be made for the placement of diving and support equipment on board in a manner that will not affect the stability and operability of the craft.
- Complying with regulations established by the government whose waters diving operations are being conducted is essential. It is not uncommon for a government to require written permission, submit copies of intended diving procedures, to have procedures that are more conservative than this manual. Governments may require environmental impact statements. The cost of not complying with governmental regulations can be enormous.

- Arrangements for personnel must not be over looked. This not only includes arranging for a sufficient quantity of qualified personnel at all levels, but also arranging backups in the event that personnel scheduled for a job are unable to make it, and making sure that personnel know when and where they are supposed to be, and any special equipment they are to bring.

2.5 Chart and Checklists

The charts and checklists are provided to assist the project planner complete the Job Hazard Analysis. (see addendum #1)

3. Safety

3.1 General

This section is intended to cover general safety rules and regulations relating to operations and equipment not dealt with in other sections. *Caldwell Marine International* divers and contractors should become intimately familiar with this section. **SAFETY IS A FULL-TIME JOB**. The more conscientious each employee becomes regarding safety, the safer and cost effective each job becomes.

- No standards will ever exist which can substitute for common sense, sound judgment, and a continuing concern for operation risk management.
- The procedures contained in this manual represent the minimum acceptable diving safety procedures to be employed in commercial diving operations.
- It is recommended that deviation from these procedures should only be undertaken when, in the opinion of the diving supervisor that a emergency situation exists and these procedures would do harm.
- Decompression procedures established in the US Navy Diving Manual Revision 6 will be used as a guideline and it will be the responsibility of all diving personnel to know and understand them so as to establish a safe and healthful working environment fir the diver.

3.2 Emergency Services

At all times while diving operations are being carried out, emergency services must be available and be able to proceed by the fastest means of transport to the location of the diving operations in the event of an life threatening emergency.

3.3 Diving Operations

- Water craft of any kind shall not come alongside a vessel from which diving operation are being conducted while a diver is in the water. The only exception to this rule is when the diver is working out of a stage or diving bell and the diving supervisor has giving his permission.
- Precaution shall be taken to ensure that the divers umbilical does not be come fowled in the propellers of the diving support vessel.
- Prior to lifting heavy objects from the bottom the diver should leave thewater.
- Appropriate signals, accordance with figure 3 –1, shall be displayed when

conducting diving operations. Adendum #XX

- Every precaution must be taken to prevent the divers umbilical from becoming fowled on hazards on the bottom.
- All efforts must be taken to isolate or shutdown any equipment/systems at the work site that present a potential hazard to the diver.
- Diver will not cut any lines until their purpose is known and permission is given from topside.
- The depth of the water, condition of the diver shall determine the length of the dive.
- No diver who shows apparent sings of intoxication, its after-effects (hangover), or is under the influence of drugs will be allowed on any dive station.
- Skylarking, horseplay, or carelessness will not be allowed on any diving station.
- All adjoining work activities shall be informed prior the commencement of diving operations.
- When a diver enters a pipeline, wreck, structure, tunnel, or any other restricted underwater area, another diver shall be available at the point of entry to tend the diver who has entered the enclosed space. **SCUBA DIVING IN ENCLOSED SPACES IS NOT PERMITTED.**
- All tools passed to the diver or recovered from the diver shall be turned off.
- If the diving supervisor does not feel that the divers fully understands all the safety aspects of the task, the diver shall not be used for the job.
- Divers should not dive with colds, sinus or lung congestion.
- The diver shall make sure that he fully understands the task the he is being asked to perform.
- Any diver who is taking medicine for any reason will inform the diving supervisor of the type of medicine and what for. All medicine must be cleared by a diving medical doctor prior to diving.

3.4 Responsibilities of the Diving Supervisor

The Diver Supervisor is on the frontline of this companies construction operation. He is responsible for the safe practices of all diving personnel and non-diving personnel working in his diving station. **SAFETY IS NEVER TO BE JEOPARDIZED TO ACHIEVE A TASK.** To realize this important responsibility the following items are considered the minimum standards.

- Enforce safety procedures and company policy
- Inform employees of safe practices
- See that all practical recommendations are carried out. If there is a conflict with set procedures bring it to the attention of management for the benefit of all employees.
- Ensure the all accidents are fully investigated and all reports are submitted in a timely manner, and that corrective measures are put in place to protect against the accident happing again.
- Stay up to date with new diving techniques, and assist in teaching the new methods to fellow employees.
- Stay current in US Navy techniques for treating Arterial Gas Embolism and Decompression Sickness.

- Maintain an open exchange of information between management and employees.
- Maintain accurate records.
- Establish dive plans with the safety of the dive team first in mind.

3.5 Diving Personnel Responsibilities

As an employee of Caldwell Marine International Group you are our most valued asset.

- Develop and utilize correct and safe working practices at all times.
- Use the proper tool for the task at han.
- If you notice damage on equipment for example, a crack weld or stuck valve bring it up to your supervisor so it can be fixed, more importantly so the equipment does not get put into service during a diving operation and fail while in use by a diver in the water or under pressure in a chamber.
- The proper PPE is worn at all times
- Report all injuries immediately and completely.
- Participate in daily JAG review and safety meetings.
- Correct hazards under your jurisdiction and report those outside your responsibility to your supervisor.
- Practice good house keeping in your work areas
- Only use tools that are cleaned for Oxygen use on an Oxygen system.

3.6 Deck and General Safety

All personnel:

- Stand clear of all lines, hoses, diving equipment, and high-pressure flasks and diver supply hoses.
- Deck Crew:
- Exercise care while loading materials around diving gear and diving equipment. If you should accidentally damage any diving gear or equipment bring it to the attention of the diving supervisor so a proper inspection can be accomplished.
- Do not move any diving equipment without permission of the diving supervisor and unless a member of the dive team is present.
- Do not touch any diving equipment especially do not change any valve configurations, line voltage that is connected as a primary or backup sourced for the diver, without permission of the diving supervisor.

3.7 Deck Crew Directly Assisting the Divers

- Be alert follow instructions carefully.
- Take order only from the diving supervisor.
- Do not wander off from your assigned station unless properly relieved by the diving supervisor.
- Know and be able to identify the meaning of diver line signals.
    - 1 Line Pull - All Stop
    - 2 Line Pulls - Provide Slack on the Divers Hose
    - 3 Line Pulls - Pick-up Slack on Divers Hose

- 4 Line Pull - Pick-up Slack – Diver Surfacing
- Repeated Line Pulls - Emergency, Bring the Diver Up ASAP

3.8 Crane Operators

- When it becomes necessary to move any diving equipment around have a dive team member assist in positioning.
- Should you accident bump into the diving equipment while moving a load notify the diving supervisor
- When assisting in diving operations maintain two-way radio communication with the diving supervisor. Under no circumstances accept any instructions or signals from anyone other than the diving supervisor.
- Understand the task being performed and all hand signals and radio communication expected to be used with the diving supervisor.

3.9 Uses and Storage of Gas Cylinders

NEVER

- Never use cylinders as rollers or supports even when they are empty.
- Never use valve protection caps for lifting cylinders.
- Never use a hammer or wrench to open cylinder valves.
- Never drop or allow any cylinder to fall especially oxygen.
- Never tamper with fuse plugs.

ALWAYS

- Always open cylinder valves slowly to allow the pressure in the system to come up gradually.
- Always keep cylinders far enough away from hot areas so that sparks, slag or flames will not reach them.
- Always store cylinders, both full and empty, so they can not be knocked over.
- Always soap test new connections.
- Always shut valves when finished with them even for a short time.
- Always use the proper “T” wrench to key to open valves on cylinders such acetylene.
- Always replace the cylinder valve cap when the regulator is removed.
- Always tie cylinders down.
- Always store cylinders in a ventilated area.
- Always mark empty cylinders.

3.10 Oxygen Safety Precautions

Oxygen is the most hazardous gas generally handled during diving operations. Oxygen lowers the ignition temperature of flammable substances and accelerates combustion. Hydrocarbons (oil grease ect.) can spontaneously combust in high Oxygen environments. The following rules apply when working with pure or high Oxygen percentages.

- Equipment used with oxygen must be designed for such use.
- Always use a clean oxygen regulator to get oxygen form a cylinder.
- **Never lubricate or allow oil or grease to come in contact with oxygen**

connections, or other oxygen equipment.

- Oxygen systems with pressures greater than 125 psig must have slow opening shut-off valves.
- All lubricants, gaskets, plastics, diaphragms, o-ring materials ect, use in oxygen systems must be O_2 compatible.
- All oxygen system must be assembled free of organic materials and loose particles. All valves, gauges, piping, used in oxygen systems must be Certified "Cleaned for Oxygen Service."
- The Recompression Chamber environment will be maintained at19 to 25 present. Chamber occupants will not be allowed flammable material in with them.
- Clothes, blankets, bedding and other materials used in recompression chamber must be made of fire retardant materials.
- Never use oxygen for compressed air or as a source of pressure.
- The minimum psig in an O_2 cylinder 25psi.

3.11 Operation and use of equipment underwater

Whether it is a screwdriver, specially designed tool, or welding torch, the diver will be thoroughly familiar with and experienced in use of what ever underwater tool is being used at the time.

- Never use a tool is not in good working condition.
- Do not overburden the work site.
- Arrange to have all required gear and tools readily available.
- Power tools shall be off when sent to a diver and when brought to the surface.
- If a hydraulic or pneumatic is available to perform the task required never use a electrically powered tool as a substitute.
- Never lower or drop tools or materials on divers or subsea assets. Always perform any driops next to the diver or assets.

3.12 Underwater Cutting and Welding

Underwater cutting and welding operations involve several hazards, including lethal electrical currents, oxygen and hydrogen rich gases that will explode in the presence of a spark and electrode tip, with temperatures in excess of 10,000°F. It is impossible to anticipate all possible situations that may arise in underwater cutting or welding operations. Consequently, it cannot be assumed that safe operating conditions will exist simply by blindly following the guidelines set forth in this manual. Nonetheless, with a thorough knowledge of cutting and welding fundamentals combined with the use of common sense and sound judgment, the procedures described in this manual can be performed in maximum safety.

3.12.1 Explosive Gases

A. Gases produced by underwater cutting are rich in oxygen and hydrogen and will explode if trapped and ignited. Gases from underwater cutting will collect in closed compartments, open tubular structural members, open piping systems, shaped structural

members and under such members as "H" beams. Before cutting, it is mandatory that provision be made to evacuate existing gases and eliminate the possibility of further gas entrapment. If the presence of trapped explosive gas mixtures is uncertain, it may be necessary to drill holes in suitable locations to allow the gases to escape. This will flood the compartment with seawater. An alternative would be to purge the compartment with a mixture of gases, which will not support combustion. Underwater cutting and welding processes generate explosive gases.

- When cutting with power on or welding, hydrogen and oxygen are dissociated from the water and will travel separately as bubbles. These bubbles can collect in a trapped or confined space overhead. As the hydrogen and oxygen gases combine they will ignite, causing a popping sound.
- Oxygen cutting is about 60 percent efficient, resulting in approximately 40 percent pure oxygen being released into the environment. This gas can become entrapped above the work area, and when combined with a fuel such as hydrocarbons, can easily be ignited by a hydrogen bubble or a spark trapped in the bubble. Any pop is a sign of explosive gases collecting above the underwater work area and is the point when cutting or welding must stop and the cause investigated.
- Prior to the start of any underwater cutting or welding, as built drawings and physical configuration of the work area must be studied to determine all these areas and voids that could contain or trap explosive gases. These areas and voids must be vented or made inert in accordance to prevent possible explosions.
- Care should also be taken when cutting or welding on enclosures that are on or above riverbeds, especially in mud, because trapped methane gas in the proper concentrations can explode.

B. Any one or a combination of the following may produce explosive gases:

- Petroleum products such as gasoline, fuel oil or greases;
- Paint mixing mediums, such as linseed oil or thinners;
- Epoxies, adhesives and solvents;
- Ammunition or bulk explosives;
- Decaying vegetable or animal matter; and
- Unburned gases from cutting torches.
- Every precaution must be taken to prevent an underwater explosion. To minimize the possibility of explosions from trapped gasses, the following procedures are recommended:
- Start cutting at the highest point and work downward.
- When cutting thick material, i.e., propeller shafting, cut from the outside and work around the circumference. By withdrawing the electrode every few seconds to allow water to enter the cut, exceedingly high temperatures can not build up inside the metal.
- Brushing or stroking action in the direction of the intended cut should be used.
- Gases may be vented to the surface with a vent tube (flexible hose) secured in place from the high point where gases would collect to a position above the waterline.

3.12.2 Electricity Underwater

A. Electricity Underwater

Electricity and water are incompatible by nature and the use of electrically powered equipment underwater presents a potential shock danger to both the diver and the tender. When using electrically powered equipment such as cutting, welding or underwater lighting, the diver and tender must be protected from electric shock. All personnel engaged in underwater cutting and welding should be thoroughly trained in CPR and first-aid so they can render immediate assistance in the event of an accident. There are many conditions that contribute to making underwater work difficult. These include adverse currents, unstable footing, poor visibility and low temperatures. A constant source of danger comes from the falling or rolling of cut-away pieces. This is especially true in salvage wrecking. These, combined with the dangers involved in operating an electric arc capable of producing fatal shock, severe burns and explosive gas pockets, create a situation where the diver must be extremely alert.

The following precautions must be observed:

- Careful examination should be made before starting the cut to learn how the cut-away pieces will fall and whether there are any projections, wires or other objects which may foul lines or cause a piece to swing around in an unexpectedmanner.

- Be extremely careful when cutting tightly-bound wire rope e.g., wire wrapped in a ship's propeller. When severed, the wire can backlash with spring-like force.
- Before cutting, ensure that umbilical and diving equipment will not be in the path of slag from the cutting operation.
- Avoid cutting overhead if possible, since the falling molten material will seriously damage the diving helmet, dress and umbilical.
- Never put down or carry an electrode holder while the power is on.
- Never change an electrode while the power is on.
- The diver must never allow any body part or equipment to come in contact with the grounded work when the safety switch is closed.
- Care should be taken with diver-carried large loose metallic items (i.e., wrenches and backpacks) to ensure no contact is made with a live electrode or the work.

B. Power Supply

The power supply used for underwater cutting or welding shall consist of only approved electric welding machines and shall be tested for proper working order prior to use. **Use only DC welding powe**r. Competent, experienced personnel in accordance with approved plans shall install electric welding equipment. This requirement is especially applicable to the installation of primary power lines and outlets intended to supply power to the electric welding machines. The equipment shall only be operated in accordance with the manufacturers recommended operating procedures and the safety precautions outlined in this manual. The following precautions are to be observed during set up and operation of arc cutting or welding equipment:

- Ensure that the welding machine frame and supporting structure are grounded before starting operations.
- Ensure that neither terminal of the welding machine is or becomes short-circuited to the machine frame before starting operations.

- Ensure that all electrical connections are securely made before starting operations.
- d. Stand on dry wood, rubber matting or similar insulating material and not on grounded metal.
- Wear dry rubber or rubberized-canvas gloves that are in good condition when handling energized holders, torches, cables or welding machines.
- Keep the welding machine commutators clean to prevent excessive flashing.
- Keep the welding machine clean and operable, free of oil and grease and (in electrical parts) free of metallic particles that can cause short circuits.

C. Electrode Holders and Cutting Torches

The following are electrode holder and cutting torch precautions that should be observed:

- Use only torches and electrode holders that have been specifically designed for under-water applications. They must have the capacity to handle the maximum rated current required by the electrode being used.
- Inspect the apparatus and ensure that all current-carrying parts are fully insulated with nonconducting material. This material should safely insulate against the maximum voltage encountered to ground. Remember, new does not necessarily

  mean ready for use. Extra insulation may be required, which will provide further diver protection and extend the life of the electrode holder.
- Standard holders designed for surface use shall not be used except in exceptional situations.
- Inspect the electrode holders for worn or damaged parts and insulating material and repair or replace any parts as necessary. Flashback arrestors and monel screens must always be in proper working order.
- Do not lower the welding or cutting torch before the ground clamp is securely attached near the work area.
- Before lowering or raising the electrode holder or ground clamp, ensure that the current is off and the knife switch is open.
- Never attempt to change or tighten an electrode with the current on.
- Never hold the holder so the electrode points toward the body. This can be likened to pointing a loaded pistol at oneself.
- Special care should be taken to avoid touching the metal parts of the diving equipment with the electrode or any uninsulated parts of the electrode holder.

D. Power Cable and Connector Safety

The following are power cable and connector safety precautions that should be observed:

- All parts of the cables that are intended to be submerged shall be fully insulated and watertight. This cannot be overstated.
- Inspect cables and cable connections for damaged insulation before starting operations. Defects in the cable must be repaired or the cable replaced before starting operations.
- All connections shall be made tight and thoroughly insulated by wrapping in rubber tape, applying a layer of scotch cote, then wrapping with electrical tape. This will prevent current loss at the connections. Cables that produce bubbles during

operation should be replaced. The bubbles indicate that current is being lost through the porous insulation.

- Use only welding cables that are a minimum of 2/0 extra flexible. An exception is the electrode holder lead, which can be 1/0. The 1/0 lead is more flexible and will aid the diver in maneuvering the electrode holder. The cable must conform to the applicable requirements of Military Specification MIL-C-915. Cables must be capable of handling the maximum current requirements of the intended work.
- Do not use excessive lengths of cable with large sections stored on deck. When working in deep water, a strain relief should be provided across the connections to support cable weight.
- When connecting lengths of cable, use connectors that have a current carrying capacity that is equivalent to the cable being used.
- Ensure that the 1/0 stinger lead between the electrode holder and the welding lead is defect-free. The cable connection coupling the stinger lead to the 2/0 welding lead should be thoroughly insulated with a layer of scotch cote, wrapped in rubber tape, insulated with an additional layer of scotch cote, then finally wrapped with electrical tape or heat-shrink tubing. This will afford added protection for the diver.

WARNING: The position of the ground in relation to the diver must be such that at no time does the diver or equipment become positioned between the ground and the electrode. The diver must avoid becoming part of the electrical circuit.

- Secure the ground clamp as close to the work-site as possible, preferably in the forward line of vision. The diver must face the ground when welding or cutting. A good rule-of-thumb to remember is: NEVER TURN YOUR BACK TO THE GROUND WHEN THE POWER IS ON.
- Keep additional power cables such as underwater light cables and welding leads separated.
- Cables should be strung overhead if they are to be run for long distances. If this is not practicable and they must be laid on deck, they must be protected and arranged to prevent interference with safe passage of personnel.
- When portable lighting is used, it should be clamped or fully secured in position and not hand held. The portable lighting power cords must be kept clear of the welding leads and work area. Additionally, a ground-fault detector/interrupter (GFD/I) must be incorporated in the circuit.
- Cables in storage should be kept dry and free of grease and oil, which cause premature breakdown of the insulation.

CAUTION: When AC power is required for underwater lighting or operation of hand tools, the AC equipment must be protected by ground-fault detection (GFD) and/or ground-fault interruption (GFI) devices.

D. Safety Switch

A positive-acting, infusible current interrupt switch, rated at 400 amperes must be in the welding circuit. This switch protects the diver by breaking the electric circuit, thereby

stopping the current supply to the electrode holder. The safety switch, more often referred to as a knife switch, is the most important safety item included in the underwater cutting or welding equipment inventory. The diver is fully isolated from electric current when the knife switch is open. The tender (phone talker) should only be instructed to close the switch when the electrode is poised for cutting or welding. It is extremely important to mount the switch correctly. The switch must be positively acting, rigidly mounted and located so that it cannot be accidentally knocked or vibrated closed. Should the switch fall, the circuit would be broken. Both double-pole and single-pole safety switches are authorized, however a double-pole is the most often used because both the working and ground lead are opened or closed simultaneously. To ensure safety switch effectiveness, the following guidelines must be followed:

- When using a single-pole knife switch, it should be located in the welding-lead side of the electric circuit and should be able to handle the maximum welding current.The safety switch must be mounted vertically on a non-conducting (wooden, plastic, etc.) stand. The switch has an open circuit potential of approximately 80 volts across the poles. To prevent accidents, the safety switch should be fitted with a non-conducting slotted cover.
- When reverse polarity is required, the safety switch must be placed in the cutting or welding lead side of the circuit.
- Never operate a knife switch in a combustible atmosphere.
- The knife switch must be in proper working order. Additionally, the switch contact surfaces should be periodically checked for verdigris accumulation.
- The current shall be off (knife switch open) at all times, except when poised for or actually cutting or welding.
- When a single-pole knife switch is used, special care must be taken to ensure that the safety switch is not shunted out between the switch and weldingmachine.
- Wet, bruised or worn cables can be shorted by rubbing against the welding machine frame, hatch combings or by lying on a steel deck. This creates a potential source of danger. Inspect the cable thoroughly and wrap any questionable spots in the insulation with rubber tape, followed by an additional layer of electrical tape or heat shrink.
- Periodic inspection should be made to ensure that the insulation is not damaged.
- The safety switch shall be located in such a position that enables the phone talker or designated tender to operate or oversee the operation of the switch during the entire time the diver is in the water. The switch shall not be closed unless specifically directed by the diver to do so. The phone talker shall confirm each change to the diver via the intercommunications system.

E. Fire and Explosion Prevention

The major causes of fire and explosion are listed as follows:

- Combustibles reached by the arc,
- Flying sparks,
- Hot slag,
- Misuse of compressed gases and cylinders and
- Short circuits.

- It is necessary for the diving supervisor be aware of topside work being conducted in the vicinity of the diving station. Do not allow welding or cutting in an area where there are combustibles. Sparks and slag can fly up to 35 feet. Keep equipment clean and operable, free of oil and grease and free of metallic particles (in electrical parts) that can cause short circuits.
- Hydrocarbons ignite almost spontaneously in the presence of oxygen. **Never allow oxygen-carrying components to come in contact with oil or grease.**

3.13 Hand tools

- Hand tools are often misused simply because the user has never been shown how to use the tool the proper way.
- Wrenches should be inspected frequently to eliminate worn or sprung jaws, broken cages, springs, and bent or cracked handles.
- Frequently inspect driving faces of hammers, chisels, drift pins, bars and similar tools to eliminate mushroomed heads, broken faces, cracked handles and other defects.
- Handles should be sound and securely wedged or fastened to the tools. Painting or taping of handles are prohibited for these practices may cover defects orcracks.
- Keep hand tools clean and in good working order.

3.14 Explosives

Prevention of explosive accidents depends on careful planning and faithful observance of proper blasting practices. The slightest abuse or misdirection of explosives may either kill or cause serious injury to yourself or others. Two general statements may be made about safety and the uses of explosives: (1) a blaster most important responsibility is safety; and (2) the safety of every blasting operation depends on itspeople.

The most important ingredients in a safety program are the quality of it people and the quality of their training. If explosives are to be used on a project a complete Explosive Safety Plan will be completed by the planner covering all aspects of safety and State, Federal, or Governmental regulations. The planner will ensure that the blasting crew is well trained in the blasting technique to be used, and that all safety precautions that can be taken are taken to protect personnel and equipment.

3.15 Confined Space Entry/Tunnel Penetration

Divers are often required to work in an enclosed or confined space. Enclosed space diving shall be supported by a surface-supplied air system.

NOTE Physically Confining Space is any space which would restrict the diver's ability to rotate head to toe, 180 degrees in any plane and/or when the diver has no direct access to the surface or bell for recovery of the diver from the water.

Enclosed Space Hazards: The interior of sunken ships, barges, pipelines, and cofferdams is hazardous due to limited access, poor visibility, and slippery surfaces. Enclosed spaces may be dry or flooded, and dry spaces may contain a contaminated atmosphere.

NOTE: When a diver is working in an enclosed or confined space an additional diver shall be stationed at the underwater point of diver ingress and immediately available to come to the assistance of the diver. In these conditions the dive team must include an additional Tender/Diver, ultimately, the number of tending divers deployed depends on the situation and the good judgment of the Diving Supervisor on the site.

Enclosed Space Safety Precautions:. Because of the hazards involved in enclosed space operations, divers must rigorously adhere to the following warnings.

WARNING: During enclosed space diving, all divers shall be outfitted with a surface supplied rig that includes a diver-to-diver and diver-to-topside communications system and a Bailout Bottle for the diver inside the space.

WARNING: For a dry penetration the divers shall not remove their diving equipment until the atmosphere tests confirm that the atmosphere is safe to breath the air will be tested constantly and the diver must be ready at all times to don his diving rig.

WARNING: If the diving equipment should fail, the diver shall immediately switch to the Bailout Bottle and abort the dive. The Bailout Bottle must have an adequate supply of air to support the diver from the deepest penetration point of the dive. The air requirem.ent for the Bail out Bottle shall be determined during the planning stages of the dive.

Working Around Corners: When working around corners where the umbilical is likely to become fouled or line-pull signals may be dissipated, a second diver (tending diver) may be sent down to tend the lines of the first diver at the obstruction and to pass along any line-pull signals. Line-pull signals are used when audio communications are lost, and are passed on the first diver's lines; the tending diver uses his own lines only for signals directly pertaining to his own situation.

Pre Entry Planning: A site specific HASP is required before entry into a confined space. The plan will cover all aspects of the planned operation; entry and egress form the confined space, health hazards physical chemical biological, emergency response plan. Additionally the HASP will include any permits required by local, state and federal governments.

Training of Personnel: A diving certification is not considered a certification to enter a confined space. The entire crew will be trained in confined space entry and rescue.

4. Equipment Requirements

In order to ensure the safety and wellbeing of the diver, the equipment used in diving operations must be designed to adequately perform the service required, properly maintained in accordance with Governmental regulations, and manufacturers specifications. This section will provide details of the requirements which equipment must meet prior to being used in diving operations conducted by *Caldwell Marine International* divers.

4.1 General System Requirements

To be considered complete, and safe for diving operations a diving system must include the following equipment:

- The equipment must be maintained and certified as per governmental regulations
- The equipment must be capable of supplying the correct gas mixer at the proper standard cubic feet (SCF) and pressure as required for depth.
- A Recompression Chamber is required for any dives deeper than 60 feet or for any dives requiring decompression, or when live-boating at anydepth.
- Voice communications between top side and all divers is required.
- An accurate depth-measuring device is required.
- First aid equipment
- Wet suit, dry suit or hot water suit system which will maintain the diver's body temperature
- A system, which will allow the diver to enter and safely exit the water, is required.

4.2 Diving Supervisor Responsibilities

Prior to the beginning of any diving operation, the diving Supervisor shall ensure that:

- That all equipment with the exception of mobile equipment required for the job is in place, ready for immediate use and secured firmly in place for the duration of the project.
- That the deck recompression chamber is readily accessible to divers returning from underwater operations.

At a minimum every 24 hours the diving Supervisor shall check:

- That all diving systems and equipment being used are in good working order.
- That all diving equipment has been leak tested.
- That all diving systems valve line up configurations have not been tampered with by non-diving personnel.

4.3 Diver Worn Equipment

For the proposes of this manual, diver worn equipment shall include all equipment required for the safety and the wellbeing of the diver, which is worn by or attached to the diver while he is in the water. When required by *Caldwell Marine International*, divers will use equipment specified and provided by *Caldwell Marine International*. No exceptions will be made without the permission of *Caldwell Marine International* management, except in the event of an emergency.

4.3.1 Helmets

The divers' helmet is the most important piece of equipment. Improperly maintained helmets put the diver at an extreme risk. Helmets/masks used by *Caldwell Marine International* divers will:

- Have a non-return check valve located at the attachment point of the umbilical to the helmet.

- Must have an exhaust valve.
- Have reliable two-way communications system

- Must supply the diver with a vent rate of 4.5 (acfm) at any depth the helmet is operated at.
- Dive Superintendent will check helmet certifications and do a visual inspection.

4.3.2 Pre-dive Checks

Immediately prior to each use, a helmet/mask will receive the following checks:

- Visual inspection for obvious signs of damage to the frame, faceplate, breathing system, neck dam, etc.
- Proper operation of the gas system including al regulators and valves.
- A vacuum test performed on the non-return valve.
- A communication check.

4.3.3 Thermal Protection

It is the responsibility of the diver to provide himself with and maintain a wet suit or dry suit, which will provide thermal protection

Suit Selection. Custom wet suits designed for cold-water diving, variable volume dry suits, and hot water suits have all been used effectively for diving in extremely cold water. Each has advantages and disadvantages that must be considered when planning a particular dive mission. All suits must be inspected before use to ensure they are in good condition with no seam separations or fabric cuts.

4.3.4 Wet Suits

Custom wet suits have the advantages of wide availability, simplicity and less danger of catastrophic failure than dry suits. Although the wet suit is not the equipment of choice, if used the following should be considered:

- The wet suit should be maintained in the best possible condition to reduce water flushing in and out of the suit.
- Wearing heavy insulating socks under the boots in a wet suit will help keep feet warm.

CAUTION In very cold water, the wet suit is only a marginally effective thermal protective measure, and its use exposes the diver to hypothermia and restricts available bottom time. The use of alternative thermal protective equipment should be considered in these circumstances.

4.3.5 Variable Volume Dry Suits

Variable volume dry suits provide superior thermal protection to the surface-supplied or scuba diver in the water and on the surface. They are constructed so the entry zipper or seal and all wrist and neck seals are waterproof, keeping the interior dry. They can be inflated orally or from a low-pressure air source via an inlet valve. Air can be exhausted from the

suit via a second valve, allowing excellent buoyancy control. The level of thermal protection can be varied through careful selection of the type and thickness of long underwear. However, too much underwear is bulky and can cause overheating, sweating, and subsequent chilling of the standby diver. Dry suit disadvantages are increased swimmer fatigue due to suit bulk, possible malfunction of inlet and exhaust valves, and the need for additional weights for neutral buoyancy. Further-more, if the diver is horizontal or deployed with the head below the rest of the body, air can migrate into the suit lower extremities, causing over inflation and loss of fins and buoyancy control. A parting seam or zipper could result in a dramatic loss of buoyancy control and thermal shock. Nevertheless, because of its superior thermal protection, the dry suit is an essential component of extremely cold water diving.

4.3.6 Extreme Exposure Suits/Hot Water Suits

Hot water suits provide excellent thermal protection. If their use can be supported logistically, they are an excellent choice whenever bottom times are lengthy. They are impractical for use by standby divers exposed on the surface. A hot water system failure can be catastrophic for a diver in very cold water since the hot water is a life support system under such conditions. Hot water temperature must be carefully monitored to ensure that the water is delivered at the proper temperature. Should dive conditions/durations require the use of a hot water suit system it will be provide by the company.

4.3.7 Pre-dive Checks and Maintenance

The flowing are checks that should be conducted prior to each use.

- Inspect the zipper slides.
- Check foam for gouges, rips or parting of the seams.
- Checks boots and gloves for damages.
- After each dive clean rinse, and dry the suit, boots and gloves with fresh clean water.
- Store in a dry location avoid folding for long periods.

4.3.8 Safety Harness/Bailout bottle

All divers must wear a safety harness. This harness will have a positive buckling device and an attachment ring for the umbilical that distributes the pulling force of the umbilical over the body of the diver, and prevent a direct strain form being placed on the diver helmet. The harness will also have a ring/loop to which a line can be attached for lifting the diver up and over the side in an emergency.

For all surface supplied dives, a bailout bottle will be used. It will be at a minimum equal to or greater than 19 cubic feet. It shall provide the total quantity of breathing mixture available for use by a diver until the standby diver reaches him and they can:

- Return to the surface and carry out the appropriate decompression procedures during the return
- Or standby diver provides the stricken diver with another source of air and than

abort the dive carrying out the appropriate decompression procedures during the return.

4.3.9 Knife

Several types of knives are available. Diving knives should have corrosion-resistant blades and a handle of plastic, hard rubber, or wood. Handles made of wood should be waterproofed with paint, wax, or linseed oil. Handles of cork or bone should be avoided, as these materials deteriorate rapidly when subjected to constant saltwater immersion. Cork may also float the knife away from the diver. Knives may have single-or-double- edged blades with chisel or pointed tips. The most useful knife has one sharp edge and one saw-toothed edge. All knives must be kept sharp. The knife must be carried in a suitable scabbard and worn on the diver's, harness, hip, thigh, or calf. The knife must be readily accessible, must not interfere with body movement, and must be positioned so that it will not become fouled while swimming or working. The scabbard should hold the knife with a positive but easily released lock. **The knife and scabbard must not be secured to the weight bel**t. If the weights are released in an emergency, the knife may be also dropped unintentionally.

4.3.10 Umbilical

The primary link to the divers is the umbilical. It carries breathing gas to the diver, a means of communications, and a method of measuring the diver depth. Also if the time duration and water temperature are a factor the umbilical carries hot water to the diver for thermal protection.

- A divers umbilical must be marked in the following manner: Every (10) foot from 10' to the 100' feet with one blue stripe; every (50) feet a red stripe will be added; and every (100) feet a yellow stripe will be added (USCG).
- It will consist of a least of the following:
  1. Gas hose.
  2. Communication cable.
  3. Pneumofathometer.
  4. Strength member.

4.4 Gas Hose Requirements

The air hose is the most important part of the umbilical. Failure of the air hose can put the diver at extreme risk of drowning. All breathing gas hoses use by Caldwell Marine International will meet the following minimum standards:

- Have a maximum working pressure that is equal to or exceeds the maximum working pressure of system being used, and the pressure equivalent of the maximum depth of the dive relative to the supply source plus 100 psig.
- Have a bursting pressure that is 4 times its maximum working pressure.
- Be made of kink-resistant material
- Have connectors which are corrosion resistant, are resistant accidental disengagement, and have a working pressure at least equal to the hose to which they are attached.

- Be tested in accordance with section 4.7.2

4.5 Breathing Gas Systems

Regardless of the source, the air must meet certain established standards of purity, must be supplied in an adequate volume for breathing, and must have a rate of flow that properly ventilates the helmet or mask. The air must also be provided at sufficient pressure to overcome the bottom water pressure and the pressure losses due to flow through the diving hose, fittings, and valves. The air supply requirements depend upon specific factors of each dive such as depth, duration, level of work, number of divers being supported, and type of diving system being used.

4.5.1 Requirements for Air Supply

All surface-supplied diving systems must include a primary and a secondary air supply. The primary supply must be able to support the airflow and pressure requirements for the diving equipment designated. The capacity of the primary supply must meet the consumption rate of the designated number of divers for the full duration of the dive (bottom time plus decompression time). The maximum depth of the dive, the number of divers, and the equipment to be used must be taken into account when sizing the supply. The secondary supply must be sized to be able to support recovery of all divers using the equipment and dive profile of the primary supply if the primary supply sustains a casualty at the worst-case time (for example, immediately prior to completion of planned bottom time of maximum dive depth, when decompression obligation is greatest). Primary and secondary supplies may be either high-pressure (HP) bank-supplied or compressor-supplied

4.5.2 Air Supply Flow Requirements

The required flow from an air supply depends upon the type of diving apparatus being used. The open-circuit air supply system must have a flow capacity (in acfm) that provides sufficient ventilation at depth to maintain acceptable carbon dioxide levels in the mask or helmet. Carbon dioxide levels must be kept within safe limits during normal work, heavy work, and emergencies. The flow requirements for respiration in a demand system are based upon the average rate of airflow demanded by the divers under normal working conditions. The maximum instantaneous (peak) rate of flow under severe work conditions is not a continuous requirement, but rather the highest rate of airflow attained during the inhalation part of the breathing cycle. The diver’s requirement varies with the respiratory demands of the diver’s work level.

4.5.3 Supply Pressure Requirements

In order to supply the diver with an adequate flow of air, the air source must deliver air at sufficient pressure to overcome the bottom seawater pressure and the pressure drop that is introduced as the air flows through the hoses and valves of the system.

4.5.4 Water Vapor Control

A properly operated air supply system should never permit the air supplied to the diver to

reach its dew point. Controlling the amount of water vapor (humidity) in the supplied air is normally accomplished by one or both of the following methods:

- Compression/Expansion. As high-pressure air expands across a pressure reducing valve, the partial pressure of the water vapor in the air is decreased. Since the expansion takes place at essentially a constant temperature (isothermal), the partial pressure of water vapor required to saturate the air remains unchanged. Therefore, the relative humidity of the air is reduced.

- Cooling the air prior to expanding it raises its relative humidity, permitting some of the water to condense. The condensed liquid may then be drained from the system.

4.5.5 Air Compressors

Low pressure air compressors used in diving operations conducted by Caldwell Marine International personnel must have:

- A certified volume tank that meets required specifications.
- A check valve on the inlet side.
- A pressure gauge.
- A drain valve
- An intake, which is located away from areas containing exhaust, fumes from internal combustion engines or other harmful contaminates.
- An efficient filtration system.
- Slow opening relief valves when the system operating pressure exceeds 500 psi.

4.5.6 Gas Purity Standards

Gas used in diving operations conducted by Caldwell Marine International divers will meet the following standards for purity:

- Oxygen Federal Specification BB-O-925a, and be type 1 (gaseous) grade A or B.
- Nitrogen Federal Specification BB-N-411c, and be of type 1 (gaseous) class 1 (oil-free) and of grade A, B, or C.
- Helium grades A, B, or C produced by the U.S. Federal Government, or Equivalent Grade D is oil pumped and will not be used.
- Compressed Air must contain:

Constituent	**Specification**
Oxygen	(percent by volume) 20-22%
Carbon dioxide	(by volume) 1,000 ppm (max)
Carbon monoxide	(by volume) 20 ppm (max)
Total hydrocarbons	(by volume) 25 ppm (max)
Oil, mist, particulates	5 mg/m3 (max)
Odor and taste	not objectionable

4.5.7 Gas Cylinder Color Codes

Color coding systems are not standards and can very significantly. To determine what gas is contained in a cylinder the making on the cylinder must be used not the color the cylinder.

4.6 Deck Chambers

Recompression chambers are used for the treatment of decompression sickness, and for surface decompression procedures. Diving operations to depths greater than 60 fsw, live-boating operations, and any dives requiring decompression, must have a chamber be available at the dive site.

4.6.1 Basic Requirements

Double-lock chambers are used because they permit tending personnel and supplies to enter and leave the chamber during treatment.

4.6.2 Standard Features

Recompression chambers must be equipped with a means for delivering breathing oxygen to the personnel in the chamber. The inner lock should be provided with connections for demand-type oxygen inhalators. Oxygen can be furnished through a high- pressure manifold connected with supply cylinders outside the chamber.

4.6.3 Labeling

All lines should be identified and labeled to indicate function, content and direction of flow.

4.6.4 Inlet and Exhaust Ports

Optimum chamber ventilation requires separation of the inlet and exhaust ports within the chamber. Exhaust ports must be provided with a guard device to prevent accidental injury when they are open.

4.6.5 Pressure Gauges

Chambers must be fitted with appropriate pressure gauges. These gauges, marked to read in feet of seawater (fsw), must be calibrated to ensure accuracy.

4.6.6 Relief Valves

Recompression chambers should be equipped with pressure relief valves in each manned lock. Chambers that do not have latches (dogs) on the doors are not required to have a relief valve on the outer lock. In addition, all chambers shall be equipped with a gag valve, located between the chamber pressure hull and each relief valve. This gag valve shall be a quick acting, ball-type valve, sized to be compatible with the relief valve and its' supply piping. The gag valve shall be safety wired in the openposition

4.6.7 Communications System

Chamber communications are provided through a diver's intercommunication system, with the dual microphone/speaker unit in the chamber and the surface unit outside. The communication system should be arranged so that personnel inside the chamber need not interrupt their activities to operate the system. The backup communications system may be

provided by a set of standard sound-powered telephones. The press-to-talk button on the set inside the chamber can be taped down, thus keeping the circuit open.

4.6.8 Lighting Fixtures

Consideration should be given to installation of a low-level lighting fixture (on a separate circuit), which can be used to relieve the patient of the heat and glare of the main lights. Emergency lights for both locks and an external control station are mandatory.

4.6.9 State of Readiness

Since a recompression chamber is emergency equipment, it must be kept in a state of readiness. The chamber shall be well maintained and equipped with all necessary accessory equipment. A chamber is not to be used as a storage compartment. The chamber and the air and oxygen supply systems shall be checked prior to each use with the Predive Checklist provided at the end of this section. All diving personnel shall be trained in the operation of the recompression chamber equipment and should be able to perform any task required during treatment.

4.6.10 Post dive Checklist

To ensure equipment receives proper post dive maintenance and is returned to operational readiness, perform the equipment checks listed in the Recompression Chamber Post dive Checklist provided at the end of this section.

4.6.11 Diving Craft and Platforms

Regardless of the technique being supported, craft used for diving operations shall:

- Be seaworthy
- Include required lifesaving and other safety gear
- Have a reliable engine (unless it is a moored platform or barge)
- Provide ample room for the divers to dress
- Provide adequate shelter and working area for the support crew
- Be able to carry safely all equipment required for the operation
- Have a well-trained crew

Other support equipment—including barges, tugs, floating cranes or vessels may be needed, depending on the type of operation. The need for additional equipment should be anticipated as far in advance as possible.

4.7 Miscellaneous equipment

4.7.1 Diving Ladders

Diving ladders should be constructed of corrosion resistant material or preserved so as to prevent corrosion. It should be able to support the weight of two divers. It must extend at least 1meter below the surface. The ladder must be fixed firmly in place and have two hand rails extending above the deck of the support craft.

4.7.2 Diving Stages

Diving stages should be constructed of corrosion resistant material or preserved so as to prevent corrosion. It should be able to support the weight of two divers. It must have a open grating platform. A diving stage must be certified for man use.

4.7.3 First Aid Equipment

Each diving operation must have at the dive location and ready for immediate use:

- The Med kits are the responsibility of the diving supervisors when he has custody of the kits of them, but Company safety department will stock maintain the kits.

A medical kit approved by a physician that contains basic and advanced medical supplies necessary for the treatment of illness, minor first aid and trauma related injuries resulting from hyperbaric exposure and non-diving related illness and injuries. The Med kit will be inventoried before and after each job and at six- month intervals:

- Copies of a current emergency first aid handbook
- A bag-type manual resuscitator with mask and tubing.
- A two-way communications system for emergencies.
- A capability to assist an injured diver into the deck recompression chamber.

4.8 Equipment Test Requirements

This section is provided to outline the test requirements for diving system and equipment used by Caldwell Marine International divers.

4.8.1 Chamber Maintenance

Scheduled Maintenance.

Proper care of a recompression chamber requires both routine and periodic maintenance. Every recompression chamber (shall be pressure tested upon installation, at 2-year intervals thereafter, after a major overhaul or repair, and each time it is moved. This test shall be conducted in accordance with the pressure test for recompression chambers contained at the end of this section. The completed test form shall be retained until retest is conducted. Chamber relief valves shall be tested to verify setting. Each tested relief valve shall be tagged to indicate the valve set pressure, date of test, and testing activity. After every use or once a month, whichever comes first, the chamber shall receive routine maintenance in accordance with the Post dive Checklist. At this time, minor repairs shall be made and used supplies shall be restocked.

Inspections. At the discretion of the diving maintenance supervisor, but at least once a year, the chambers shall be inspected, both inside and outside. Any deposits of grease, dust, or other dirt shall be removed and, on steel chambers, the affected areas repainted.

Corrosion. Corrosion is removed best by hand sandpaper or by using a scraper, being careful not to gouge or otherwise damage the base metal. The corroded area and a small

area around it should then be cleaned to remove any remaining paint and/or corrosion and the surface repainted.

4.8.2 Gas Hose test

- Each breathing gas supply hose will be tested initially and every 12 months thereafter, to 1.5 times the maximum working pressure.
- Each breathing gas supply hose will be internally cleaned of hydrocarbons and particulates initially and every 18 months thereafter.
- Divers umbilical will have a coupling pullout test initially and every 12 months.

RECOMPRESSION CHAMBER PREDIVE CHECKLIST	
Equipment	**Initials**
Chamber	
Cleared of all extraneous equipment	
Clear of noxious odors	
Doors and seals undamaged, seals lubricated	
Remove floor Plates	
Visually inspect chamber interior for oily or volatile deposits of any kind	
Replace floor plates	
Inspect view ports for cracks clouding or pitting	
Shut outer hatch and pressurize chamber to 75 psi	
Inspect all hull penetrations and snoop for leaks	
Pressure gauges calibrated/compared	
Release pressure open outer hatch	
Air Supply System	
Primary and secondary air supply adequate	
One-valve supply: Valve closed	
Equalization valve closed, if applicable	
Supply regulator set at 250 psig or other appropriate pressure	
Fittings tight, filters clean, compressors fueled	
Exhaust System	
Valve closed and calibrated for ventilation	
Oxygen Supply System	
Cylinders full, marked as BREATHING OXYGEN, cylinder valves open	
Replacement cylinders on hand	
Built in breathing system (BIBS) masks installed inspected for damage and tested. Clean all BIBS mask with Non-Ionic soap	
Supply regulator set in accordance with OPs	
Fittings tight, gauges calibrated	
Oxygen manifold valves closed	
BIBS dump functioning	

RECOMPRESSION CHAMBER PREDIVE CHECKLIST	
Equipment	**Initials**
Electrical System	
Lights	
Oxygen analyzer calibrated	
Direct Current (DC) power supply	
Communication System	
Primary system tested	
Secondary system tested	
Fire Prevention System	
Fire-retardant clothing worn by all chamber occupants	
Fire-resistant mattresses and blankets in chamber	
Means of extinguishing a fire	
Miscellaneous	
Urinal	
Primary medical kit	
Ear protection, sound attenuators/aural protectors (1 set per person) Must have a 1/16" hole drilled to allow for equalization.	
Stopwatches for recompression treatment time, decompression time, personnel leaving chamber time, and cumulative time.	
U.S. Navy Diving Manual Revision 6	
Ventilation bill	
Chamber log	
Operating Procedures (OPs) and Emergency Procedures (EPs)	
Bedpan (to be locked in as required)	

RECOMPRESSION CHAMBER POSTDIVE CHECKLIST	
Equipment	**Initials**
Air Supply	
All valves closed	
Compressors fueled and maintained per technical manual/PMS requirements	
View Ports and Doors	
View-ports checked for damage; replaced as necessary	
Door seals checked, replaced as necessary	
Door seals lightly lubricated with approved lubricant	
Door dogs and dogging mechanism checked for proper operation and shaft seals for tight-ness	
Chamber	
Inside wiped clean with Nonionic Detergent (NID) and warm fresh water	
All but necessary support items removed from chamber	
Blankets cleaned and replaced	
All flammable material in chamber encased in fire-resistant containers	
Primary medical kit restocked as required	
Chamber aired out	
Outer door closed	
Deckplates lifted, area below Deckplates cleaned, Deckplates reinstalled	
Support Items	
*U.S. Navy Diving Manua*l, Operating Procedures (OPs), Emergency Procedures (EPs), ventilation bill and pencil available at control desk	
Secondary medical kit restocked as required and stowed	
Clothing cleaned and stowed	
All entries made in chamber log book	
Chamber log book stowed	
Oxygen Supply	
BIBS mask removed, cleaned per current PMS procedures, reinstalled	
All valves closed	
System bled	
Breathing oxygen cylinders fully pressurized	
Spare cylinders available	
System free of contamination	
Exhaust System	
Exhaust: valves closed	

PRESSURE TEST FOR *Caldwell Marine International* RECOMPRESSION CHAMBERS

NOTE: All Caldwell Marine International recompression chambers are restricted to a maximum working pressure of 100 psig (225 fsw), regardless of design pressure rating.

A pressure test shall be conducted on every recompression chamber:

- When initially installed
- When moved and reinstalled
- After repairs/overhaul
- At two-year intervals at a given location

Performance of the test and the test results are recorded on a Chamber Air Pressure and Leak Test form (attached).

The test is conducted as follows:

1. Pressurize the innermost lock to 100 fsw (45 psig). Using soapy water or an equivalent solution, leak test all shell penetration fittings, view-ports, dog seals, door dogs (where applicable), valve connections, pipe joints, and shell weldments.
2. Mark all leaks. Depressurize the lock and adjust, repair, or replace components as necessary to eliminate leaks.

   a. View-Port Leaks. Remove the view-port gasket (replace if necessary), wipe clean.

CAUTION
Acrylic view-ports should not be lubricated or come in contact with any lubricant. Acrylic view-ports should not come in contact with any volatile detergent or leak detector (non- ionic detergent is to be used for leak test). When reinstalling view-port, take up retaining ringbolts until the gasket just compresses evenly about the view-port. Do not over compress the gasket.

   b. Weldment Leaks. Contact appropriate technical authority for guidance on corrective action.

3. Repeat steps 1 and 2 until all the leaks have been eliminated.
4. Pressurize lock to 225 fsw (100 psig) and hold for 5 minutes.
5. Depressurize the lock to 165 fsw (73.4 psig). Hold for 1 hour. If pressure drops below 145 fsw (65 psig), locate and mark leaks. Depressurize chamber and repair leaks in accordance with Step 2 above and repeat this procedure until final pressure is at least145
fsw (65 psig).
6. Repeat Steps 1 through 5 leaving the inner door open and outer door closed. Leak test only those portions of the chamber not previously tested.

RECOMPRESSION CHAMBER

AIR PRESSURE AND LEAK TEST
(Sheet 2 of 3)
Facility test is conducted _____

NAME PLATE DATA

Manufacturer _____

Date of Manufacture _____

Contract/Drawing No. _____

Maximum Working Pressure _____

Date of Last Pressure Test _____

Test Conducted by _____

1. Conduct visual inspection of chamber to determine if ready for test

Chamber Satisfactory_____Initials of Test Conductor

Discrepancies from visual inspection of chamber:

_____

_____

2. Close inner door lock. With outer lock door open pressure inner lock to 100 fsw (45psig) and verify that the following components do not leak:

Inner lock leak checks Initials of Test Conductor.

A. Shell penetrations and fittings	___Satisfactory
B. View Ports	___Satisfactory
C. Door Seals	___Satisfactory
D. Door Dog Shaft Seals	___Satisfactory
E. Valve Connections and Stems	___Satisfactory
F. Pipe Joints	___Satisfactory
G. Shell Welds	___Satisfactory

3. Increase inner lock pressure to 225 fsw (100 psig) and hold for 5 minutes.

Record Test Pressure_____Satisfactory (Note: Disregard small leaks at this pressure).

RECOMPRESSION CHAMBER
AIR PRESSURE AND LEAK TEST
(Sheet 3 of 3)

4. Depressurize lock slowly to 165 fsw (73.4 psig). Secure all supply and exhaust valves and hold for one hour.

Start Time_____ Pressure 165 fsw

End Time_____ Pressure_____ fsw

If pressure drops below 145 fsw (65 psig) locate and mark leaks. Depressurize, repair, and retest inner lock.
Inner Lock Pressure drop test passed _____ Satisfactory Initials of Test Conductor.

5. Depressurize inner lock and open inner lock door. Secure in open position. Close outer door and secure.

6. Repeat tests of sections 2, 3, and 4 above when set up in accordance with section Leak test only those portions of the chamber not tested in sections 2, 3, and 4.

7. Outer Lock Checks Initials of Test Conductor

A. Shell penetrations and fittings	___Satisfactory
B. View Ports	___Satisfactory
C. Door Seals	___Satisfactory
D. Door Dog Shaft Seals	___Satisfactory
E. Valve Connections and Stems	___Satisfactory
F. Pipe Joints	___Satisfactory
G. Shell Welds	___Satisfactory

8. Maximum Chamber Operating Pressure (100 psig) Test (5 minute hold)

Satisfactory_____ Initials of Test Conductor

9. Inner and Outer Lock Chamber Drop Test
   Start Time_____ Pressure 165 fsw
   End Time_____ Pressure_____ fsw
10. All above tests have been satisfactorily completed.

_____	_____	_____
Test Conductor Date	Diving Supervisor Date	Maintenance Supervisor Date

5. Surface-Supplied Air Diving

5.1 Limits

- Surface-supplied air diving shall not be conducted at depths deeper than 190 fsw, except dives with bottom times of 30 minutes or less may be conducted to depths of 220 fsw.
- A decompression chamber shall be ready for use at the dive location for any dive outside the no-decompression limits or deeper than 60 fsw. A decompression chamber is required for dives deeper than 60 fsw when live boating.
- A bell shall be used for dives with an in water decompression time greater than 120 minutes, except when heavy gear is worn or diving is conducted in physically confining spaces.

5.2 Minimum Personnel

The minimum number of personnel comprising a dive team must take into consideration not only the direct requirements of work to be performed, but also any additional factors either known or suspected that would require more personnel to support the diving operation. Question: Looking at the ADCI Operational Guidelines Pgs 51-55 Below Ranges 0-80, 80-130 , 130-220 are different ranges and requirements than the ADCI manual. As this is not my area of exoertise, I would not be able to advise you on the above ranges but would suggest consider following current ADCI Operational gudielines

Surface Supplied Air Diving 0 – 80 fsw with no decompression:

- 1 – Diving Supervisor
- 1 – Diver
- 1 – Tender/Standby Diver

Surface Supplied Air Diving 80 – 130 fsw, or less than 80 fsw when decompression is required:

- 1 – Diving Supervisor
- 1 – Diver
- 1 – Standby Diver
- 1 – Tender

Surface Supplied Air Diving 130 – 220 fsw:

- 1 – non Diving Supervisor
- 1 – Diver
- 1 – Standby Diver
- 2 – Tenders

Working with large Crews in shallow water less than 130 fsw

- When working in shifts with 2 eight-man crew's a non-diving supervisor is required for each shift.
- When working with 2 four-man crews on the same shift at different locations on a single vessel or facility, a non-diving supervisor is required.
- When working with 2 four-man crews on different shifts on a single vessel or facility, a non-diving supervisor is not required.

5.3 General Surface Supplied Procedures

The following are minimum requirements for surface supplied air diving operations.

- Each diver shall be continuously tended while in the water.
- A diver shall be stationed at the underwater point of entry when diving is conducted in enclosed or physically confining spaces.
- Each diving operation shall have a primary breathing gas supply sufficient to support divers for the duration of the planned dive including decompression.
- Diving depth limitations are based on secondary breathing gas availability. A dive-location secondary breathing gas supply shall be provided and be capable of supporting two divers and a standby for the duration of the required decompression during an emergency.
- For dives deeper than 100 fsw or outside the no-decompression limits:
- A separate dive team member shall tend each diver in the water;
- A standby diver shall be available while a diver is in the water;
- A diver-carried reserve breathing gas supply (bailout) shall be provided for each diver when diving at all times regardless of depth, when direct ascent to the surface is not available, except when heavy gear is worn.
- For heavy-gear diving deeper than 100 fsw or outside the no-decompression limits an extra breathing gas hose capable of supplying breathing gas to the diver in the water shall be available to the standby diver.
- A separate safety harness with a positive buckling device shall be worn. The harness shall prevent any strain from being placed on the diver's mask or helmet.
- In the event that diving operations require in-closed space diving a diver shall be stationed at the underwater point of entry.
- An operational two-way voice communication system shall be used between:
- Each surface-supplied air diver and a dive team member at the dive location or bell (when provided or required);
- An operational, two-way communication system shall be available at the dive location to obtain emergency assistance.
- Decompression, repetitive, and no-decompression tables (as appropriate) shall be at the dive location.
- A depth-time profile shall be maintained for each diver during the dive including decompression.
- A means capable of supporting the diver shall be provided for entering and exiting the water.
- The means provided for exiting the water shall extend below the water surface for a minimum of three feet and be adequate to facilitate rescue of injured personnel.
- Dive team members shall be briefed on the tasks to be undertaken, safety procedures for the diving mode being used and emergency procedures.

5.4 Minimum Equipment

5.4.1 Shallow Air (0 to 80 fsw, 60 fsw when live boating)

- Adequate air source and volume tank to support two (2) divers;
- Dive location emergency air source
- Two (2)-diver umbilicals each consisting of air hose, strength member, communications cable, and pneumofathometer hose.
- 1 Set of the U.S. Navy No-decompression tables, Repetitive dive tables, and air decompression and treatment tables
- 1 Safe practices/Operations Manual;
- 1 Control station consisting of communication system and depth gauges;
- Safe means of getting a diver of the water;
- 1 Basic First Aid kit with First Aid Manual and Bag type Manual Resuscitator;
- Two Sets of diver's personal diving equipment consisting of helmet or mask, weight belt if appropriate, protective clothing, tools as required, safety harness, diver carried reserve breathing gas supply (bailout), sharp knife.
- Two time keeping devices;
- Log book and/or dive sheets

5.4.2 Deep Air (in excess of 80 fsw, 60 fsw when live boating)

- Two adequate air sources and volume tanks to support two (2) divers;
- 1 Double-lock recompression chamber;
- 1 Set air decompression and treatment tables;
- Dive location emergency air source;
- 1 Diving stage (all dives deeper than 100 fsw, outside no decompression limits, or with heavy diving gear;
- Two (2)-diver umbilicals each consisting of air hose, strength member, communications cable, and pneumofathometer hose.
- 1 Safe practices/Operations Manual;
- 1 Control station consisting of communication system and depth gauges;
- Safe means of getting a diver of the water;
- 1 Basic First Aid kit with First Aid Manual and Bag type Manual Resuscitator;
- Two sets of diver's personal diving equipment consisting of helmet or mask, weight belt if appropriate, diver carried reserve breathing gas supply (bail out), protective clothing, tools as required, safety harness, diver carried reserve breathing gas supply (bailout), sharp knife;
- Adequate supply of oxygen for recompression treatments;
- Spare parts as required;
- 2 Time keeping devices;
- Log book and/or dive sheets

5.5. Post-Dive Procedures

After the completion of any dive, the Dive Supervisor shall:

- Check the physical condition of the diver.
- Instruct the diver to report any physical problems or adverse physiological effects including symptoms of decompression sickness.
- Advise the diver of the location of a recompression chamber that is ready foruse
- Alert the diver to the potential hazards of flying after diving.
- For any dive outside the no-decompression limits, deeper than 100 fsw or using mixed gas as a breathing mixture, the Dive Supervisor shall instruct the diver to remain awake and in the vicinity of the decompression chamber which is at the dive location for at least one hour after the dive (including decompression or treatment as appropriate).

5.6 Recompression Capability

- A recompression chamber capable of recompressing the diver at the surface to a minimum of 165 fsw (6 ATA) shall be available at the dive location for:
- Surface-supplied air diving to depths deeper than 60 fsw and shallower than 220 fsw;
- Diving outside the no-decompression limits shallower than 220 fsw.
- Live boating deeper than 60 fsw .
- The recompression chamber shall be:
- Dual-lock;
- Multi-place.
- Located within 5 minutes of the dive location.
- The recompression chamber at a minimum shall be equipped with:
    - A pressure gauge for each pressurized compartment designed for human occupancy
    - A built-in-breathing-system with a minimum of one mask per occupant
    - A two-way voice communication system between occupants and a dive team member at the dive location
    - A view port for each lock
    - Illumination capability to light the interior of the chamber
    - Treatment tables, treatment gas appropriate to the diving mode, and sufficient gas to conduct treatment shall be available at the divelocation.
    - A dive team member shall be available at the dive location during and for at least one hour after the dive to operate the decompression chamber (when required or provided).

5.7 Record of Dive

The following information shall be recorded and maintained for each diving operation:

- Names of dive team members including designated person-in-charge
- Date, time, and location
- Diving modes used
- General nature of work performed
- Approximate underwater and surface conditions (visibility, water temperature and current); and

- Maximum depth and bottom time for each diver
- For each dive outside the no-decompression limits, deeper than 100 fsw or using mixed gas, the following additional information shall be recorded and maintained
- Depth-time and breathing gas profiles
- Decompression table designation (including modification); and
- Elapsed time since last pressure exposure if less than 24 hours or repetitive dive designation for each diver
- 5.7.1 Recompression Procedure Assessment
- For each dive in which decompression sickness is suspected or symptoms are evident, the following additional information shall be recorded and maintained
- Description of decompression sickness symptoms (including depth and time of onset); and
- Description and results of treatment
- The employer shall:
- Investigate and evaluate each incident of decompression sickness based on the recorded information, consideration of the past performance of decompression table used, and individual susceptibility
- Take appropriate corrective action to reduce the probability of recurrence of decompression sickness
- Prepare a written evaluation of the decompression procedure assessment, including any corrective action taken, within 45 days of the incident of decompression sickness.

5.8 Air Diving Procedures

5.8.1 Introduction

When air is breathed under pressure, nitrogen diffuses into various tissues of the body. This nitrogen uptake by the body occurs at different rates for the various tissues. It continues as long as the partial pressure of the inspired nitrogen in the circulatory and respiratory system is higher than the partial pressure of the gas absorbed in the tissues. Nitrogen absorption increases as the partial pressure of the inspired nitrogen increases, such as with increased depth. Nitrogen absorption also increases as the duration of the exposure increases, until tissues become saturated.

As a diver ascends, the process is reversed. The partial pressure of nitrogen in the tissues comes to exceed that in the circulatory and respiratory systems. During ascent, the nitrogen diffuses from the tissues to the lungs. The rate of ascent must be carefully controlled to prevent the nitrogen pressure from exceeding the ambient pressure by too great of an amount. If the pressure gradient is uncontrolled, bubbles of nitrogen gas can form in tissues and blood, causing decompression sickness.

To reduce the possibility of decompression sickness, special decompression tables and schedules were developed. These schedules take into consideration the amount of nitrogen absorbed by the body at various depths and times. Other considerations are the allowable pressure gradients that can exist without excessive bubble formation and the different gas-

elimination rates associated with various body tissues. Because of its operational simplicity, staged decompressions used for air decompression. Staged decompression requires decompression stops in the water at various depths for specific periods of time.

5.8.2 AIR Decompression Definition

The following terms are frequently used when conducting diving operations and discussing the decompression tables.

- Descent Time. *Descent time* is the total elapsed time from when the divers leave the surface to the time they reach the bottom. Descent time is rounded up to the next whole minute.
- Bottom Time. *Bottom time* is the total elapsed time from when the divers leave the surface to the time they begin their ascent from the bottom. Bottom time is measured in minutes and is rounded up to the next whole minute.
- Decompression Table. A *decompression table* is a structured set of decompression schedules, or limits, usually organized in order of increasing bottom times and depths.
- Decompression Schedule. A *decompression schedule* is a specific decompression procedure for a given combination of depth and bottom time as listed in a decompression table. It is normally indicated as feet/minutes.
- Decompression Stop. A *decompression stop* is a specified depth where a diver must remain for a specified length of time (stop time).
- Depth. The following terms are used to indicate the depth of a dive:
- *Maximum depth* is the deepest depth attained by the diver plus the pneumofathometer correction factor (Table 5- 1). When conducting scuba operations, maximum depth is the deepest depth gauge reading.
- *Stage depth* is the pneumofathometer reading taken when the divers are on the stage just prior to leaving the bottom. Stage depth is used to compute the distance and travel time to the first stop, or to the surface if no stops are required.

Pneumofathometer Correction Factors.

Pneumofathometer Depth	Correction Factor
0-100 fsw	+1 fsw
101-200	+2 fsw
201-300	+4 fsw
301-400	+7 fsw

- Equivalent Single Dive Bottom Time. The *equivalent single dive bottom time* is the time used to select a schedule for a single repetitive dive. This time is expressed in minutes.
- Unlimited/No-Decompression (No "D") Limit. The maximum time that can be spent at a given depth that safe ascent can be made directly to the surface at a prescribed travel rate with no decompression stops is the *unlimited/no-decompression* or *No "D" limit*.
- Repetitive Dive. A *repetitive dive is* any dive conducted within 12 hours of a previous dive.
- Repetitive Group Designation. The *repetitive group designation* is a letter used to indicate the amount of residual nitrogen remaining in a diver's body following a previous dive.

- Residual Nitrogen. *Residual nitrogen* is the nitrogen gas still dissolved in a diver's tissues after surfacing.
- Residual Nitrogen Time. *Residual nitrogen time* is the time that must be added to the bottom time of a repetitive dive to compensate for the nitrogen still in solution in a diver's tissues from a previous dive. Residual nitrogen time is expressed in minutes.
- Single Dive. A *single dive* refers to any dive conducted more than 12 hours after a previous dive.
- Single Repetitive Dive. A *single repetitive dive* is a dive for which the bottom time used to select the decompression schedule is the sum of the residual nitrogen time and the actual bottom time of the dive.
- Surface Interval. The *surface interval is* the time a diver has spent on the surface following a dive. It begins as soon as the diver surfaces and ends as soon as he starts his next descent.

5.8.3 Selection of Decompression Schedule

The decompression schedules of all the
tables are usually given in 10-foot depth increments and 10-minute bottom time increments. Depth and bottom time combinations from dives, however, rarely match the decompression schedules exactly. To ensure that the selected decom-pression schedule is always conservative, always select the schedule depth equal to or next greater than the maximum depth of the dive and always select the schedule bottom time equal to or next longer than the bottom time of the dive.
For example, to use the Standard Air Decompression Table to select the correct schedule for a dive to 97 fsw for 31 minutes, decompression would be selected for 100 fsw and carried out per the 100 fsw for 40 minutes (100/40) schedule.

CAUTION: Never attempt to interpolate between decompression schedules.

When planning for surface-supplied dives where the diver will be exceptionally cold or the workload is expected to be relatively strenuous, Surface Decompression should be considered. In such case, conduct decompression from the normal schedule in the water and then surface decompress using the chamber stop time(s) from the next longer schedule. When conducting dives using Standard Air Decompression Tables, select the next longer decompression schedule than the one that would normally be selected.
If the divers are exceptionally cold during the dive or if the workload is relatively strenuous, select the next longer decompression schedule than the one that would normally be selected. If the diver's depth cannot be maintained at a decompression stop, the Diving Supervisor may select the next deeper decompression table.

NOTE: Take into consideration the physical condition of the diver when deter-mining what is strenuous.

5.9 Rules During Ascent

After selecting the applicable decompression schedule, it is imperative that it be followed as closely as possible. Unless a Diving Medical Officer recommends a deviation and the

Commanding Officer concurs, decompression must be completed according to the schedule selected.

5.9.1 Ascent Rate

Always ascend at a rate of 30 fpm (20 seconds per 10 fsw). Minor variations in the rate of travel between 20 and 40 fsw/minute are acceptable. Any variation in the rate of ascent must be corrected in accordance with the procedures in paragraph 5.9.3. However, a delay of up to one minute in reaching the first decompression stop can be ignored.

5.9.2 Decompression Stop Time

Decompression stop times, as specified in the decompression schedule, begin as soon as the divers reach the stop depth. Upon completion of the specified stop time, the divers ascend to the next stop or to the surface at the proper ascent rate. Ascent time is not included as part of stop time.

Variations in Rate of Ascent Delays

in Arriving at the First Stop
Delay greater than 1 minute, deeper than 50 fsw. Add the total delay time (rounded up to the next whole minute) to the bottom time, re-compute a new decompression schedule, and decompress accordingly.
Delay greater than 1 minute, shallower than 50 fsw. If the rate of ascent is less than 30 fpm, add the delay time to the diver's first decompression stop. If the delay is between stops, disregard the delay. The delay time is rounded up to the next whole minute.

Travel Rate Exceeded
On a Standard Air Dive, if the rate of ascent is greater than 30 fpm, STOP THE ASCENT, allow the watches to catch up, and then continue ascent. If the stop is arrived at early, start the stop time after the watches catch up.

5.10 Decompression Tables

5.10.1 The Unlimited/No-Decompression

The table serves three purposes. First, the table identifies that on a dive with the depth 20 fsw and shallower, unlimited bottom time may be achieved. Second, it summarizes all the depth and bottom time combinations for which no decompression is required. Third, it provides the repetitive group designation for each unlimited/no-decompression dive. Even though decompression is not required, there is still an amount of nitrogen remaining in the diver's tissues for up to 12 hours following a dive. If they dive again within a 12- hour period, divers must consider this residual nitrogen when calculating decompression from the repetitive dive. Any dive deeper than 25 fsw that has a bottom time greater than the no-decompression limit given in this table is a decompression dive and must be conducted per the Standard Air Decompression Table.
Each depth listed in the Unlimited/No-Decompression Table has a corresponding no-decompression limit listed in minutes. This limit is the maximum bottom time that divers

may spend at that depth without requiring decompression. Use the columns to the right of the no-decompression limits column to obtain the repetitive group designation. This designation must be assigned to a diver subsequent to every dive.

5.10.2 U.S. Navy Standard Air Decompression Schedules

This manual combines the Standard Air Decompression Schedules and Exceptional Exposure Air Schedules into one table. To clearly distinguish between the standard (normal) and exceptional exposure decompression schedules, the exceptional exposure schedules have been separated by a bold line.

NOTE: Never conduct planned exceptional exposure dives.

If the bottom time of a dive is less than the first bottom time listed for its depth, decompression is not required. The divers may ascend directly to the surface at a rate of 30 feet per minute (fpm). The repetitive group designation for a no-decompression dive is given in the Unlimited/No-Decompression Table. As noted in the Standard Air Decompression Table, there are no repetitive group designations for exceptional exposure dives. Repetitive dives are not permitted following an exceptional exposure dive.

5.10.3 Repetitive Dives

During the 12-hour period after an air dive, the quantity of residual nitrogen in divers' bodies will gradually be reduced to its normal level. If the divers are to make a second dive within this period (repetitive dive), they must consider their residual nitrogen level when planning for the dive.

Upon completing the first dive, the divers are assigned a repetitive group designation from either the Standard Air Decompression Table or the Unlimited/No-Decompression Table. This designation relates directly to the residual nitrogen level upon surfacing. As nitrogen passes out of the diver's tissues and blood, their repetitive group designation changes. By using the Residual Nitrogen Timetable (Table 9- 7), this designation may be determined at any time during the surface interval.

To determine the decompression schedule for a repetitive dive using either the unlimited/no-decompression, standard air, or surface decompression table:

- Determine the residual nitrogen level just prior to leaving the surface of the repetitive dive (based on the repetitive dive depth), using the Residual Nitrogen Timetable. This level is expressed as residual nitrogen time, in minutes.
- Add this time to the actual bottom time of the repetitive dive to get the Equivalent Single Dive Time (ESDT).
- Conduct decompression from the repetitive dive using the max depth (MD) and the equivalent single dive time to select the appropriate decompression schedule. Avoid equivalent single dives requiring the use of Exceptional Exposure decompression schedules. Always use a systematic Repetitive Dive Worksheet, when determining the decompression schedule for a repetitive dive.

5.10.4 Residual Nitrogen Timetable for Repetitive Air Dives

The quantity of residual nitrogen in a diver's body immediately after a dive is expressed by the repetitive group designation assigned from either the Standard Air Decompression Schedule or the Unlimited/No-Decompression Table. The upper portion of the Residual Nitrogen Timetable is composed of various intervals between 10 minutes and 12 hours. These are expressed in hours and minutes (2:21 = 2 hours, 21 minutes). Each interval has a minimum time (top limit) and a maximum time (bottom limit). Residual nitrogen times corresponding to the depth of the repetitive dive is given in the body of the lower portion of the table. To determine the residual nitrogen time for a repetitive dive:

- Locate the diver's repetitive group designation from the previous dive along the diagonal line above the table.
- Read horizontally to the interval where the diver's surface interval lies. The time spent on the surface must be between or equal to the limits of the selected interval.
- Read vertically down to the new repetitive group designation. This corresponds to the present quantity of residual nitrogen in the diver's body.
- Continue down in this same column to the row representing the depth of the repetitive dive. The time given at the intersection is the residual nitrogen time, in minutes, to be applied to the bottom time of the repetitive dive.

5.10.5 RNT Exception Rule

An exception to this table occurs when the repetitive dive is made to the same or greater depth than that of the previous dive. This is referred to as the RNT Exception Rule. In such cases, the residual nitrogen time may be longer than the bottom time of the previous dive. A diver's body cannot contain more residual nitrogen than it was originally exposed to. To obtain the equivalent single dive time, simply add the bottom time of the previous dive to that of the repetitive dive. (All of the residual nitrogen passes out of a diver's body after 12 hours, so a dive conducted after a 12-hour surface interval is not a repetitive dive.)

5.11 Surface Decompression

Surface decompression is a technique for fulfilling all or a portion of a diver's decompression obligation in a recompression chamber instead of in the water, significantly reducing the time that a diver must spend in the water. Also, breathing oxygen in the recompression chamber reduces the diver's total decompression time.

Surface decompression offers many advantages that enhance the divers' safety. Shorter exposure time in the water keeps divers from chilling to a dangerous level. Inside the recompression chamber, the divers can be maintained at a constant pressure, unaffected by surface conditions of the sea. Divers shall be observed constantly by either the inside tender or topside personnel, and monitored for decompression sickness and oxygen toxicity.

If an oxygen breathing system is installed in the recompression chamber, conduct surface decompression according to the Surface Decompression Table Using Oxygen. If air is the only breathing medium available, use the Surface Decompression Table Using Air.

Residual Nitrogen Timetables have not been developed for Surface Decompression Repetitive Dives. Repetitive surface decompression dives may be accomplished in accordance with 5.12.

5.11.1 Surface Decompression Table Using Oxygen.

Using the Surface Decompression Table Using Oxygen (referred to as Sur D O2) requires an approved double-lock recompression chamber with an oxygen breathing system. With Sur D O2, divers ascend at a constant rate of 30 fpm. The divers are decompressed to the first decompression stop (or to the surface if there are no water stops required) at an ascent rate of 30 fpm. The travel rate between stops and from 30 fsw to the surface is also 30 fpm (:20 per 10 fsw). Minor variations in the rate of travel between 20 and 40 fpm are acceptable. Once the divers are on the surface, the tenders have three and a half (:03:30) minutes to remove the breathing apparatus and diving dress and assist the divers into the recompression chamber.

Pressurizing the recompression chamber with air to 40 fsw should take approximately 30 seconds (descent rate not to exceed 80 fpm). The total elapsed time from when the divers leave the 30 foot stop (or 30 fsw if no water stops are required) to when they reach the 40 foot recompression chamber stop must not exceed 5 minutes.

During descent in the recompression chamber, if a diver cannot clear and the chamber is at a depth of at least 20 fsw, stop, then breathe oxygen at 20 fsw for twice the 40 fsw chamber stop time. Ascend to 10 fsw and breathe oxygen again for twice the 40 fsw chamber stop time. Then ascend to the surface. This “safe way out” procedure is not intended to be used in place of normal Sur D O 2 procedures.

If the prescribed surface interval is exceeded and the divers are asymptomatic, treat them as if they have Type I decompression sickness (Treatment Table 5,). If the divers are symptomatic, they are treated as if they have Type II decompression sickness (Treatment Table 6,), even if they are only displaying Type I symptoms. Symptoms occurring during the chamber stops are treated as recurrences

Upon arrival at 40 fsw in the recompression chamber, the divers are placed on the Built-in Breathing System (BIBS) mask breathing pure oxygen. The mask should not be strapped on unless there is an inside tender with the divers, the divers must hold the mask to their face and ensure a good oxygen seal.

The designated 40-foot stop time commences once the divers are breathing oxygen. The divers breathe oxygen throughout the 40 foot stop, interrupting oxygen breathing after each 30 minutes with a 5 minute period of breathing chamber air (referred to as an “air break”). Count the air breaks as “dead time” and not part of the oxygen stop time. If the air break interval falls on time to travel, remove oxygen and commence traveling to the surface at 30 fpm. This procedure simplifies time keeping and should be used whenever using the Surface Decompression Table Using Oxygen. Remove the O 2 mask prior to leaving the 40 fsw stop for the surface.

Warning: The interval from leaving 40 fsw in the water to arriving at 50 fsw in the chamber cannot exceed 5 minutes without incurring a penalty. This is new <u>in</u> the US NAVY Dive Manual revision 7.

5.11.2 Loss of Oxygen Supply in the Chamber (40 fsw Chamber Stop)

If the oxygen supply in the chamber is lost at the 40 fsw chamber stop, have the diver breathe chamber air.

- Temporary Loss. Return the diver to oxygen breathing. Consider any time on air as dead time.
- Permanent Loss. Multiply the remaining oxygen time by three to obtain the equivalent chamber decompression time on air. If 50% helium 50% oxygen or 50% nitrogen 50% oxygen is available, multiply the remaining oxygen time by two to obtain the equivalent chamber decompression time on 50/50. Allocate 10% of the equivalent air or 50/50 time to the 40-fsw stop, 20% to the 30 fsw stop, and 70% to the 20 fsw stop. Round the stop times up to the next whole minute. Surface upon completion of the 20 fsw stop.

5.11.3 CNS Oxygen Toxicity (40 fsw Chamber Stop)

At the first sign of CNS toxicity, the patient should be removed from oxygen and allowed to breathe chamber air. Fifteen minutes after all symptoms have completely subsided, resume oxygen breathing at the point of interruption. If symptoms of CNS oxygen toxicity develop again or if the first symptom is a convulsion, take the following action:

1. Remove the mask.
2. After all symptoms have completely subsided, decompress 10 feet at a rate of 1 fsw/min. For a convulsion, begin travel when the patient is fully relaxed and breathing normally.
3. Resume oxygen breathing at the shallower depth at the point of interruption.
4. If another oxygen symptom occurs, complete decompression time on air. Multiply
5. the remaining oxygen time by three to obtain the equivalent chamber decompression time on air. Allocate 30% of the equivalent air to the 30 fsw stop and 70% to the 20 fsw stop. Surface upon completion of the 20 fsw stop.

5.11.4 Repetitive Dives.

There are no repetitive diving tables or surface interval tables for surface decompression dives. If another surface decompression dive using oxygen is planned within a 12-hour period, select the appropriate decompression schedule by:

- Adding the bottom times of all dives made in the previous 12 hours to get an adjusted bottom time, and
- Using the maximum depth obtained in the previous 12 hours.
- The equivalent single dive shall not exceed 170/40 for Sur D O 2 or 190/60 for Sur D Air.

5.11.5 Surface Decompression Table Using Air

The Surface Decompression Table Using Air (referred to as Sur D Air) should be used for surface decompression following an air dive when a recompression chamber without an oxygen breathing system is all that is available.

The total ascent times of the Surface Decompression Table Using Air exceed those of the Standard Air Decompression Table; the only advantages surface decompression using air are getting the divers out of the water sooner and maintaining the divers in a controlled, closely observed environment during decompression.

When using the Sur D Air table, all ascents are made at 30 fpm. This includes the ascent

rate from the last water stop. The time spent on the surface should not exceed 3½ minutes and the rate of descent to the first recompression chamber stop should not exceed 60 fpm. The total elapsed time for these three procedures must not exceed 5 minutes.
If the prescribed surface interval is exceeded and the divers are asymptomatic, they are treated as if they had Type I Decompression Sickness (Treatment Table 5 or 1A). If the divers are symptomatic, they are treated as if they had Type II Decompression Sickness (Treatment Table 6 or 2A), even if they are only displaying Type I symptoms.

5.11.6 Repetitive Dives.

If a second surface decompression air dive is planned within a 12-hour period, the same rule applies as for making a second Sur D O 2 dive

5.12 Exceptional Exposure

Exceptional exposure dives are those dives in which the risk of decompression sickness, oxygen toxicity, and/or exposure to the elements is substantially greater than on normal working dives. Decompression schedules for exceptional exposure dives are contained in the Standard Air Decompression Table. These exceptional exposure schedules are only used in emergencies, such as diver entrapment. Exceptional exposure dives should not be planned in advance except under the most unusual operational circumstances.

5.12.1 Surface Decompression Procedures for Exceptional Exposure Dives.

The long decompressions times associated with exceptional exposure dives impose unusual demands on a diver's endurance. There is also limited assurance that the dive will be completed without decompression sickness. These two risks can be reduced by using surface decompression techniques rather than completing decompression entirely in the water.

- Complete the entire 20 fsw in the water.
- Ascend to the surface at 30 fpm. Minor variations in the rate of travel between 20 and 40 fpm are acceptable.
- Once on the surface, the tenders have three and a half (:03:30) minutes to remove the breathing apparatus and diving dress and assist the divers into the recompression chamber.
- Pressurize the recompression chamber with air to 20 fsw at a travel rate of 60 fpm.
- Upon arrival at 20 fsw in the recompression chamber, the divers are placed on the Built-in Breathing System (BIBS) mask breathing 100% oxygen.
- The 20 foot stop time commences once the divers are breathing oxygen. Repeat the 20 fsw in-water stop time.
- The divers breathe oxygen throughout the 20-foot stop, interrupting oxygen breathing after each 30 minutes with a 5 minute air break. The air breaks count as part of the stop time.
- Ascend to 10 fsw at 30 fpm. Complete the 10 fsw in-water stop time. The divers breathe oxygen throughout the 10-foot stop, interrupting oxygen breathing after each 30 minutes with a 5 minute air break. The air breaks count as part of the stop time.

- Ascent to the surface at 30 fpm.

5.12.2 Oxygen System Failure (Chamber Stop).

If the oxygen system fails during a chamber stop, complete the remaining decompression time on air.

5.13 Diving At High Altitudes

Because of the reduced atmospheric pressure, dives conducted at altitude require more decompression than identical dives conducted at sea level. Standard air decompression tables, therefore, cannot be used as written. Some organizations calculate specific decompression tables for use at each altitude. An alternative approach is to correct the altitude dive to obtain an equivalent sea level dive, then determine the decompression requirement using standard tables. This procedure is commonly known as the "Cross Correction" technique and always yields a sea level dive that is deeper than the actual dive at altitude. A deeper sea level equivalent dive provides the extra decompression needed to offset effects of diving at altitude. If diving at altitudes above 300 feet refer to the US Navy dive manual for guidance.

5.13.1 Flying After Diving

Leaving the dive site may require temporary ascent to a higher altitude. Ascent to altitude after diving increases the risk of decompression sickness because of the additional reduction in atmospheric pressure the higher the altitude, the greater the risk. Pressurized commercial airline flights are addressed in Note 3 of Table 5-2.)

Table 5-2 gives the surface interval (hours: minutes) required before making a further ascent to altitude. The surface interval depends on the planned increase in altitude and the highest repetitive group designator obtained in the previous 24-hour period. Enter the table with the highest repetitive group designator obtained in the previous 24-hour period. Read the required surface interval from the column for the planned change in altitude.

Required Surface Interval Before Ascent to Altitude After Diving.

Repetitive Group Designator

Increase in Altitude

	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
A	00:00	00:00	00:00	00:00	00:00	00:00	00:00	**00:00**	00:00	00:00
B	00:00	00:00	00:00	00:00	00:00	00:00	00:00	**00:00**	00:00	02:11
C	00:00	00:00	00:00	00:00	00:00	00:00	00:00	**00:00**	03:06	08:26
D	00:00	00:00	00:00	00:00	00:00	00:00	00:09	**03:28**	07:33	12:52
E	00:00	00:00	00:00	00:00	00:00	00:51	03:35	**06:54**	10:59	16:18
F	00:00	00:00	00:00	00:00	001:12	03:40	06:23	**09:43**	13:47	19:07
G	00:00	00:00	00:00	01:23	03:34	06:02	08:46	**12:05**	16:10	21:29
H	00:00	00:00	01:31	03:26	05:37	08:05	10:49	**14:09**	18:13	23:33
I	00:00	01:32	03:20	05:15	07:26	09:54	12:38	**15:58**	20:02	24:00
J	01:32	03:09	04:57	06:52	09:04	11:32	14:16	**17:35**	21:39	24:00
K	03:00	04:37	06:25	08:20	10:32	13:00	15:44	**19:03**	23:07	24:00
L	04:21	05:57	07:46	09:41	11: 52	14:20	17:04	**20:23**	24:00	24:00
M	05:35	07:11	09:00	10:55	13:06	15:34	18:18	**21:37**	24:00	24:00
N	06:43	08:20	10:08	12:03	14:14	16:42	19:26	**22:46**	24:00	24:00
O	07:47	09:24	11:12	13:07	15:18	17:46	20:30	**23:49**	24:00	24:00
Z	08:17	09:54	11:42	13:37	15:49	18:17	21:01	**24:00**	24:00	24:00

Exceptional Exposure Wait 48 hours before flying

NOTE 1: When using Table 5-2, use the highest repetitive group designator obtained in the previous 24-hour period.

NOTE 2: Table 5-2 may only be used when the maximum altitude achieved is 10,000 feet or less.

NOTE 3: The cabin pressure in commercial aircraft is maintained at a constant value regardless of the actual altitude of the flight. Though cabin pressure varies somewhat with aircraft type, the nominal value is 8,000 feet. For commercial flights, use a final altitude of 8000 feet to compute the required surface interval before flying.

NOTE 4: No surface interval is required before taking a commercial flight if the dive site is at 8000 feet or higher. In this case, flying results in an increase in atmospheric pressure rather than a decrease.

NOTE 5: No repetitive group is given for air dives with surface decompression on oxygen or air. For these surface decompression dives, enter the standard air table with the sea level equivalent depth and bottom time of the dive to obtain the appropriate repetitive group designator to be used.

NOTE 6: For ascent to altitude following a non-saturation helium-oxygen dive, wait 12 hours if the dive was a no-decompression dive. Wait 24 hours if the dive was a decompression dive.

5.14 Emergency Procedures

Diving and the performance of work underwater, places a man in a situation that has inherent and unavoidable dangers. Even when using the best equipment manned by properly trained personnel, the possibility of and emergency may exist. Emergencies are by nature unexpected and differ form a routine failure in that they require prompt correct action to recover and prevent further deterioration of the situation. The emergency procedures (EP's) that follow for surface supplied diving operations outline the steps required to recover from known possible emergencies.

The cardinal rule of emergency procedures is the most difficult to follow – DON'T PANIC. While it is much easier to say than do, a panicky response will more than likely be wrong, and result in the further complication of the situation. While actions taken in an emergency must be quick, they must also be correct, and correct decisions are not made if you do not have a complete grasp on the situation. If the diver finds himself in an emergency situation, he should take time to assess the situation determine the correct action and what he can do for himself.

The following emergency procedures that may affect the health and safety of personnel are offered as minimum guidelines to assist companies in developing their own specific detailed emergency procedures. The steps that are listed may not be in order of preference.
Each emergency will dictate its own priorities. In general, every emergency will cause the dive to be aborted until the cause has been fully remedied.

.Loss of Breathing Media
1. Re-establish breathing media supply by:
• Activate topside secondary breathing media supply, or
• Diver go on bailout bottle, or
• Put breathing media to diver's pneumo hose and have the diver insert pneumo hose into helmet/mask.
2. Alert standby diver.
3. Diver goes to bell/stage.
4. If required, send Standby Diver to diver's assistance.
5. Terminate dive.

Loss of Communications
1. Attempt to establish line-pull signals.
2. Put air to diver's pneumo.
3. Alert Standby Diver.
4. Diver proceeds to downline/bell stage (if bell, attempt to use bell communications).
5. Bring diver to first stop once line-pull signals are established.
6. If required (unable to establish any form of communications with diver), send Standby Diver to diver's assistance prior to bringing diver to his first stop.
7. Terminate dive.

Fouled or Entrapped Diver
1. Avoid panic and ensure diver does not ditch equipment.
2. Diver informs topside.
3. Alert standby diver.
4. Diver determines extent of entrapment.
5. Diver attempts to free himself.
6. If required, send Standby Diver to diver's assistance.
7. When diver is free, if unable or unwilling to continue the dive, or if Standby Diver was required to go to his assistance, terminate dive.

Injured Diver in Water
1. Diver informs topside and dive is aborted.
2. Alert Standby Diver.
3. Diver determines nature and extent of injury.
Consensus Standards for Commercial Diving and Underwater Operations 3-41
4. If required, send Standby Diver down to assist diver, administer first aid, and evaluate injury. Standby Diver should remain with diver.5. Standby Diver assists injured diver to surface, following proper decompression procedures, except when severity of injury indicates a greater risk than omitting decompression.
6. Request required medical assistance and emergency evacuation (if required).
7. Monitor breathing. If breathing stops, overpressure diver's regulator, if possible.

Severance of Diver's Umbilical - Gas Hose Only
1. Put breathing media to diver's pneumo hose.
2. Diver activates bailout bottle.
3. Alert Standby Diver.
4. If required, diver inserts pneumo hose inside helmet/mask.
5. Diver returns to bell/stage.
6. Diver activates and uses emergency breathing media on bell/stage.
7. Terminate dive and follow proper decompression procedure.
8. If required, send Standby Diver down with additional bailout bottle or hose.

Severance of Complete Umbilical
1. Diver activates bailout bottle.
2. Alert Standby Diver.
3. Diver returns to bell/stage.
4. Diver activates and uses emergency gas on bell/stage.
5. If umbilical severed on deck and the end of the umbilical is still on deck, send Standby Diver down umbilical with new hose/bailout bottle. Otherwise, send Standby Diver down downline or bell stage cable.
6. Terminate dive and follow proper decompression procedure.

Fire in Equipment
1. Extinguish fire; secure equipment.
2. Determine damage and effect on diver.
3. If required, terminate dive; commence decompression.

4. Each chamber must have a means of extinguishing a fire in the interior.

Equipment Failure - Diver in the Water
1. Evaluate effect on diver.
2. Inform diver of problem and action planned.
3. Alert Standby Diver.
4. Alert deck crew.
5. Diver informs topside of his readiness.
6. Activate plan, terminate dive.

Oxygen Toxicity in Water
1. Supervisor notes signs or diver reports symptoms to topside.
2. Reduce oxygen partial pressure (switch to air).
3. Continue decompression on appropriate table unless a 50/50 nitrox mix is available for in-water decompression use.

Oxygen Toxicity during Treatment
1. Diver reports to topside.
2. Instruct diver to remove oxygen mask for 15 minutes. After all symptoms disappear, then start oxygen again. Do not count time not on oxygen. Recommence decompression where oxygen stopped.
3. If oxygen toxicity symptoms occur for the second (2nd) time, repeat Procedure 2.
4. If oxygen toxicity symptoms occur for the third (3rd) time, discontinue oxygen and immediately request medical advice and assistance from designated point of contact.

Emergency Evacuation
1. Notify diver and all surrounding personnel of emergency and terminate dive.
2. Decompress diver according to proper decompression procedures. If not possible, follow omitted decompression procedures.
3. Evacuate all unnecessary personnel to safe platform.
4. Contact management and inform them of conditions as soon as possible.
Additional emergency procedures should be developed as needed, possibly including but not limited to:
• Loss of power supplies
• Loss of SDC (bell)
• Loss of ROV
• Adverse environmental conditions, including but not limited to:
- Weather
- Sea state
Consensus Standards for Commercial Diving and Underwater Operations 3-43
Dive emergencies such as bailout, bends, omitted decompression, embolism, etc.

6 **SCUBA Diving**:

International Telecom divers do not normally conduct SCUBA diving operations. When the task can be performed using surface supplied techniques they should be employed. However the case may arise where a task can be more efficiently performed using SCUBA. In this case the techniques to be used is up to the on scene diving supervisor.

6.1 Limits

- SCUBA diving shall not be conducted at depths deeper than 130 fsw.
- SCUBA diving at depths deeper than 60 fsw requires a recompression chamber that is ready for use and on the dive location.
- Planned Decompression dives in SCUBA are not permitted.
- SCUBA dives shall not be conducted against currents exceeding one (1) knot.
- SCUBA diving is not permitted in enclosed or physically confining spaces.

6.2 Procedures

- A standby diver shall be available while a diver is in the water.
- A single diver shall be line-tended from the surface.
- Divers will be line-tended from the surface if direct access to the surface is not possible.
- A diver-carried reserve breathing gas supply shall be provided for each diver consisting of a manual reserve (J valve); or an independent reserve cylinder with a separate regulator.
- The valve of the reserve breathing gas supply shall be in the closed position prior to the dive.
- Dive team members shall be briefed on:
- The tasks to be undertaken;
- Safety procedures for the diving mode;
- Emergency procedures.

6.3 Termination of the dive

The dive shall be terminated when the divers go on reserve or have 500 psi remaining in their scuba bottles as read on the divers cylinder gauge.
If a situation arises to change the safe working conditions of the dive, either under the water or on the support craft, the dive should be aborted until the problem can be corrected.

6.4 Minimum SCUBA Equipment

Each diver shall be equipped with the following equipment:

- DOT approved and certified compressed gas cylinder
- Sharp knife
- Diving wristwatch
- Depth gage

- Weight belt, independent of the cylinder harness
- Cylinder harness with quick release
- Personnel floatation device
- Set of the U.S. Navy No-decompression tables, Repetitive dive tables, and air decompression and treatment tables

6.5 Buddy Diver Responsibilities.

The greatest single safety practice in scuba operations is the use of the buddy system. Dive partners operating in pairs are responsible for both the assigned task and each other's safety. The basic rules for buddy diving are:

- Always maintain contact with the dive partner. In good visibility, keep the partner in sight. In poor visibility, use a buddy line.
- Know the meaning of all hand and line-pull signals.
- If a signal is given, it must be acknowledged immediately. Failure of a dive partner to respond to a signal must be considered an emergency.
- Monitor the actions and apparent condition of the dive partner. Know the symptoms of diving ailments. If at any time the dive partner appears to be in distress or is acting in an abnormal manner, determine the cause immediately and take appropriate action.
- Never leave a partner unless the partner has become trapped or entangled and cannot be freed without additional assistance. If surface assistance must be sought, mark the location of the distressed diver with a line and float or other locating device. Do not leave a partner if voice communications or line-pull signals are being used; contact the surface and await assistance or instructions.
- Establish a lost-diver plan for any dive. If partner contact is broken, follow the plan.

6.6 Working with Tools

The near-neutral buoyancy of a scuba diver poses certain problems when working with tools. A diver is at a disadvantage when applying leverage with tools. When applying force to a wrench, for example, the diver is pushed away and can apply very little torque. If both sides of the work are accessible, two wrenches—one on the nut and one on the bolt should be used. By pulling on one wrench and pushing on the other, the counter- force permits most of the effort to be transmitted to the work. When using any tool that requires leverage or force (including pneumatic power tools), the diver should be braced with feet, a free hand, or a shoulder.

NOTE: When using externally powered tools with scuba, the diver must have voice communications with the Diving Supervisor.

Any tools to be used should be organized in advance. The diver should carry as few items as possible. If many tools are required, a canvas tool bag should be used to lower them to the diver as needed.

6.7 Ascent Procedures

When it is time to return to the surface, either diver may signal the end of the dive. When the signal has been acknowledged, the divers shall ascend to the surface together at a rate not to exceed 30 feet per minute. For a normal ascent, the divers will breathe steadily and naturally. Divers must never hold their breath during ascent, because of the danger of an air embolism. While ascending, divers must keep an arm extended overhead to watch for obstructions and should spiral slowly while rising to obtain a full 360-degree scan of the water column.

6.7.1 Emergency Free-Ascent Procedures

If a diver is suddenly without air or if the scuba is entangled and the dive partner cannot be reached quickly, a free ascent must be made. Guidelines for a free ascent are:

- Drop any tools or objects being carried by hand.
- Abandon the weight belt.
- If the scuba has become entangled and must be abandoned, actuate the quick-release buckles on the waist, chest, shoulder, and crotch straps. Slip an arm out of one shoulder strap and roll the scuba off the other arm. An alternate method is to flip the scuba over the head and pull out from underneath. Ensure that the hoses do not wrap around or otherwise constrict the neck. The neck straps packed with some single-hose units can complicate the overhead procedure and should be disconnected from the unit and not used.
- If the reason for the emergency ascent is a loss of air, drop all tools and the weight belt and actuate the life preserver to surface immediately. Do not drop the scuba unless it is absolutely necessary.
- If a diver is incapacitated or unconscious and the dive partner anticipates ifficulty in trying to swim the injured diver to the surface, the partner should activate the life preserver or inflate the buoyancy compensator. The weight belt may have to be released also. However, the partner should not lose direct contact with the diver. Exhale continuously during ascent to let the expanding air in the lungs escape freely.

7. Live-boating

7.1 Limits

- Diving operations involving live boating shall not be conducted: With an in water decompression time of greater than 120 minutes;
- Using surface-supplied air at depths deeper than 190 fsw, except that dives with bottom times of 30 minutes or less may be conducted to depths of 220 fsw;
- Using mixed gas at depths greater than 220 fsw;
- Live-boating is not allowed in seas which significantly impede the vessels station keeping capabilities, in periods of restricted visibility, or in other than daylight hours.

7.2 Minimum Personnel

Air Diving (0 to 60 fsw)
1 - Diving supervisor
2 Divers
2 Tenders

When crew size is eight or more at least one member will be a non-diving supervisor.
Air diving (60 to 220)
1 – non-Diving Supervisor
Divers
2 – Tenders

7.3 Vessel

The vessel shall be acceptable to the company and the diving supervisor.
A "Kill Switch" to shut the engines shall be in the vicinity of the operator of the boat.

7.4 Dynamically Positioned Diving Support Vessels

- No single fault should cause a catastrophic failure and move the vessel from its intended position.
- The operating requirements of the system shall never be allowed to exceed the vessels capabilities in any respect.
- Personnel shall be fully capable of performing the task entrusted to them.
- Minimum Equipment
- A third diving hose connected the manifold shall be available for emergency use.
- Regardless of depth, the diver will wear a bailout bottle.
- When in water decompression is required a free-floating decompression buoy or equivalent will be used.
- A device shall be used which minimizes the possibility of entanglement of the diver's hose in the propeller of the vessel.

7.4.1 Procedures

- The supervisor must be experienced in live-boating
- The vessel Captain should be experienced in live-boating to the satisfaction of the supervisor.
- The propeller of the vessel shall be stopped before the diver enters or exits the water.
- Two-way voice communication between the designated person-in-charge and the person controlling the vessel shall be available while the diver is in the water.
- A standby diver shall be available while a diver is in the water.
- A diver-carried reserve breathing gas supply shall be carried by each diver engaged in live-boating operations.
- The divers umbilical will always be in view of the tender and diving supervisor

8. Recompression Treatment

This section is a very basic overview of recompression procedures outlined in the US NAVY Dive Manual revision 7 It is the responsibility of International Telecom divers to read and understand the procedures outlined in the US NAVY Dive Manual revision 7 Volume 2

8.1 OMITTED DECOMPRESSION

Certain emergencies, such as uncontrolled ascents, an exhausted air supply, or bodily injury, may interrupt or prevent required decompression. If the diver shows symptoms of decompression sickness or arterial gas embolism, immediate treatment using the appropriate oxygen or air recompression treatment table is essential. Even if the diver shows no symptoms, omitted decompression must be addressed in some manner to avert later difficulty.

8.1.1 Ascent from 20 Feet or Shallower (Shallow Surfacing) with Decompression Stops Required

If the diver surfaced from 20 feet or shallower feels well, and can be returned to stop depth within 1 minute, the diver may complete normal decompression stops. The decompression stop from which ascent occurred is lengthened by 1 minute. If the diver cannot be returned to the depth of the stop within 1 minute and the diver remains asymptomatic, return the diver to the stop from which the diver ascended. Multiply each decompression stop time missed by 1.5. Alternatively, if the surface interval is less than 5 minutes, the diver may be placed in a recompression chamber and treated on a Treatment Table 5 (or 1A if no oxygen is available). If the surface interval is greater than 5 minutes, the diver may be placed in a recompression chamber and treated on Treatment Table 6 (or 2A if no oxygen is available). The diver should be observed for 1 hour after surfacing and/or completing treatment.

8.1.2 Ascent from 20 Feet or Shallower with No Decompression Stops Required

No recompression is required if the diver surfaces from 20 feet or shallower but was within no-decompression limits. The diver should be observed on the surface for 1 hour.

8.1.2Ascent from Deeper than 20 Feet (Uncontrolled Ascent)

Any unexpected surfacing of the diver from depths in excess of 20 feet is considered an uncontrolled ascent. If the diver is within no-decompression limits and asymptomatic, he should be observed for at least 1 hour on the surface. Recompression is not necessary unless symptoms develop.

8.1.4 Asymptomatic Uncontrolled Ascent

Asymptomatic divers who experience an uncontrolled ascent and who have missed decompression stops are treated by recompression based on the amount of decompression missed as follows:

- Oxygen Available. Immediately compress the diver to 60 feet in the recompression chamber. If less than 30 minutes of decompression (total ascent time from the tables) were missed, decompress from 60 feet on Treatment Table 5. If more than

30 minutes of decompression were missed, decompress from 60 feet on Treatment Table 6.

- Oxygen Not Available. Compress the diver to 100 feet in the recompression chamber and treat on Table 1A if less than 30 minutes of decompression were missed; compress to 165 feet and treat on Table 2A if more than 30 minutes were missed.

8.1.4 Development of Symptoms

As long as the diver shows no ill effects, decompress in accordance with the treatment table. Consider any decompression sickness that develops during or after this procedure to be a recurrence. Try to keep all surface intervals as short as possible (5 minutes or less). If an asymptomatic diver who has an uncontrolled ascent from a decompression dive has more than a 5-minute surface interval, recompress to 60 feet on Treatment Table 6 or treat on Table 2A, even if the missed decompression time was less than 30 minutes.

8.1.5 In-Water Procedure

When no recompression facility is available, use the following in-water procedure to make up omitted decompression in asymptomatic divers for ascents from depths below 20 feet. Recompress the diver in the water as soon as possible (preferably less than a 5- minute surface interval). Keep the diver at rest, provide a standby diver, and maintain good communication and depth control. Use the decompression schedule appropriate for the divers depth and bottom time. Follow the procedure below with 1 minute between stops:

- Return the diver to the depth of the first stop.
- Follow the schedule for stops 40-fsw and deeper.
- Multiply the 30-, 20-, and 10-fsw stops by 1.5.

8.1.6 Symptomatic Uncontrolled Ascent

If a diver has had an uncontrolled ascent and has any symptoms, he should be compressed immediately in a recompression chamber to 60 fsw. Conduct a rapid assessment of the patient, and treat accordingly. Treatment Table 5 is not an appropriate treatment for symptomatic uncontrolled ascent. If the diver surfaced from 60 fsw or shallower, compress to 60 fsw and begin Treatment Table 6. If the diver surfaced from a greater depth, compress to 60 fsw or depth where the symptoms are significantly improved, not to exceed 165 fsw, and begin Treatment Table 6A. Symptoms developing during the surface interval or during a period of observation on no-decompression dives are treated as Type II DCS. Consultation with a Diving Medical Doctor should be made as soon as possible. For uncontrolled ascent deeper than 165 feet, the diving supervisor may elect to use Treatment Table 8 at the depth of relief, not to exceed 225 fsw. Treatment of symptomatic divers who have surfaced unexpectedly is difficult when no recompression chamber is on site. Immediate transportation to a recompression facility is indicated if this is impossible.

8.1.7 Transporting the Patient

In certain instances, some delay may be unavoidable while the patient is transported to a recompression chamber. While moving the patient to a recompression chamber, the patient should be kept lying horizontally. Do not put the patient head-down. Additionally, the patient should be kept warm and monitored constantly for signs of blocked airway, cessation of breathing, cardiac arrest, or shock. Always keep in mind that a number of conditions may exist at the same time. For example, the victim may be suffering from both

decompression sickness and severe internal injuries.

8.1.8 Medical Treatment During Transport

Always have the patient breathe 100 percent oxygen during transport, if available. If symptoms of decompression sick-ness or arterial gas embolism are relieved or improve after breathing 100 percent oxygen, the patient should still be treated as if the original symptom(s) were still present. Always ensure the patient is adequately hydrated. Give fluids by mouth if the patient is able to take them. Otherwise, intravenous fluids should be started before transport. If the patient must be transported, initial arrangements should have been made well in advance of the actual diving operations. These arrangements, which would include an alert notification to the recompression chamber and determination of the most effective means of transportation, should be posted on the Job Site Emergency Assistant Checklist for instant referral.

8.1.9 Transport by Unpressurized Aircraft

If the patient is moved by helicopter or other unpressurized aircraft, the aircraft should be flown as low as safely possible, preferably less than 1,000 feet. Any unnecessary altitude means an additional reduction in external pressure and possible additional symptom severity or complications. If available, always use aircraft that can be pressurized to one atmosphere.

8.1.10 Communications with Chamber

Call ahead to ensure that the chamber will be ready and that qualified medical personnel will be standing by. If two-way communications can be established, consult with the doctor as the patient is being

8.2 Treatment Tables

Oxygen Treatment Tables are more effective and, therefore, preferable over Air Treatment Tables. Treatment Table 4 can be used with or without oxygen but should always be used with oxygen if it is available.

8.2.1 Treatment of Symptoms During Sur-D Surface Interval

If surface decompression procedures are used, symptoms of decompression sickness may occur during the surface interval. Because neurological symptoms cannot be ruled out during this short period, the symptomatic diver is treated as having Type II symptoms, even if the only complaint is pain.

8.2.2 Treating for Exceeded Sur-D Surface Interval

If the prescribed surface interval is exceeded but the diver remains asymptomatic, the diver is treated with Treatment Table 5, or Treatment Table 1A if no oxygen is available. If the diver becomes symptomatic, the diver is treated as if Type II symptoms were present. Any symptoms occurring during the chamber stops of Surface Decompression Tables are treated as recurrences.

8.2.3 Recompression Treatments When Oxygen Is Not Available

If no oxygen is available, select the appropriate Air Treatment Table in accordance with Use Table 1A if pain is relieved at a depth less than 66 feet. If pain is relieved at a depth greater than 66 feet, use Table 2A. Table 3 is used for treatment of serious symptoms where oxygen cannot be used. Use Table 3 if symptoms are relieved within 30 minutes at 165 feet. If symptoms are not relieved in less than 30 minutes at 165 feet, use Table 4.

8.2.3 Descent/Ascent Rates for Air Treatment Tables

The Air Treatment Tables (1A, 2A, 3, and 4 using air) are used when no oxygen is available. They are not as effective as the Oxygen Treatment Tables. The descent rate is 20 feet per minute the ascent rate is not to exceed 1 foot per minute.

8.2.4 Recompression Treatments When Oxygen Is Available

Use Oxygen Treatment Tables 5, 6, 6A, 4, or 7, the descent rate is 20 feet per minute. Upon reaching treatment depth not to exceed 60 fsw, place the patient on oxygen. For depth deeper than 60 fsw, use treatment gas if available. Additional guidelines for each treatment table are given below.

8.2.5 Treatment Table 5

Treatment Table 5 may be used for the following:
Type I (except for cutis-marmorata) symptoms when a complete neurological examination has revealed no abnormality.

- Asymptomatic omitted decompression of shallow surfacing (20 fsw or less) Asymptomatic omitted decompression of rapid ascent (from deeper than 20 fsw) if the missed decompression is less than 30 minutes

Asymptomatic divers who have exceeded surface interval limits following a Sur-D dive
Treatment of resolved symptoms following in-water recompression

- Follow-up treatments for residual symptoms
- Carbon monoxide poisoning

8.2.6 Performance of Neurological Exam at 60 fsw

After arrival at 60 fsw a neurological exam shall be performed to ensure that no overt neurological symptoms (e.g., weakness, numbness, incoordination) are present. If any abnormalities are found, the stricken diver should be treated using Treatment Table 6.

8.2.7 Extending Oxygen Breathing Periods on Treatment Table 5

Treatment Table 5 may be extended by two oxygen-breathing periods at 30 fsw. Air breaks are not required prior to an extension, between extensions, or prior to surfacing. In other words, the Diving Supervisor may have the patient breathe oxygen continuously for 60 minutes at 30 fsw and travel to the surface while breathing oxygen. If the Diving Supervisor elects to extend this treatment table, the tender does not require additional oxygen breathing than currently prescribed.

8.2.7 When Use of Treatment Table 6 is Mandatory

Treatment Table 6 is mandatory if:

- Type I pain is severe and immediate recompression must be instituted

before a neurological examination can be performed, or

- A complete neurological examination cannot be performed, or Any neurological symptom is present.
- These rules apply no matter how rapidly or completely the symptoms resolve once recompression begins.

8.2.8 Complete Relief after 10 Minutes

If complete relief of Type I symptoms is not obtained within 10 minutes at 60 feet, Table 6 is required.

8.2.9 Musculoskeletal Pain Due to Orthopedic Injury

Symptoms of musculoskeletal pain that have shown absolutely no change after the second oxygen breathing period at 60 feet may be due to orthopedic injury rather than decompression sick-ness. If, after reviewing the patient's history, the Diving Medical Officer feels that the pain can be related to specific orthopedic trauma or injury, Treatment Table 5 may be completed. If no Diving Medical Doctor is on site,TreatmentTable6 shall be used.

NOTE: Once recompression to 60 feet is done, Treatment Table 5 shall be used even if it was decided symptoms were probably not decompression sickness. Direct ascent to the surface is done only in emergencies.

8.3 Treatment Table 6

Treatment Table 6 is used for the following:

- Type I symptoms where relief is not complete within 10 minutes at 60 feet or where a neurological exam is not complete
- Type II symptoms Cutis marmorata
- Severe carbon monoxide poisoning, cyanide poisoning, or smoke inhalation
- Arterial gas embolism
- Symptomatic uncontrolled ascent
- Asymptomatic divers with omitted decompression greater than 30 minutes Treatment of unresolved symptoms following in-water treatment Recurrence of symptoms shallower than 60 fsw

8.3.1 Treating Arterial Gas Embolism

Arterial gas embolism is treated by initial compression to 60 fsw. If symptoms are improved within the first oxygen-breathing period, then treatment is continued using Treatment Table 6. Treatment Table 6 may be extended for two oxygen-breathing periods at 60 fsw (20 minutes on oxygen, then 5 minutes on air, then 20 minutes on oxygen) and two oxygen breathing periods at 30 fsw (15 minutes on air, then 60 minutes on oxygen, then 15 minutes on air, then 60 minutes on oxygen). If there has been more than one extension, the tenders' breathing period is extended 60 minutes at 30 feet.

8.4 Treatment Table 6A

Arterial gas embolism or severe decompression symptoms are treated by initial compression to 60 fsw. If symptoms improve, complete Treatment Table 6. If symptoms are unchanged or worsen, assess the patient upon descent and compress to depth of relief

(significant improvement), not to exceed 165 fsw. Once at the depth of relief, begin treatment gas (N 2 O 2 ,HeO 2) IAW Table 21-5 if available. Stay there for 30 minutes. A breathing period of 25 minutes on treatment gas, interrupted by 5 minutes of air, is recommended at depth to simplify time keeping. The patient may remain on treatment gas during ascent from treatment depth to 60 fsw since the PO 2 will continually decrease during ascent. Decompress to 60 fsw at a travel rate not to exceed 3 ft./min. Upon arrival at 60
fsw, complete Treatment Table 6. Consult with a Diving Medical Officer at the earliest opportunity. The Diving Medical Officer may recommend a Treatment Table 4. Treatment Table 6A may be extended for two oxygen breathing periods at 60 fsw and two oxygen breathing periods at 30 fsw. If deterioration is noted during ascent to 60 feet, treat as a recurrence of symptoms.

8.5 Treatment Table 4

If a shift from Treatment Table 6A to Treatment Table 4 is contemplated, a Diving Medical Doctor shall be consulted before the shift is made. Treatment Table 4 is used when it is determined that the patient would receive additional benefit at depth of significant relief, not to exceed 165 fsw. The time at depth shall be between 30 to 120 minutes, based on the patient's response.

8.6 Treatment Table 7

Treatment Table 7 is considered a heroic measure for treating non-responding severe gas embolism or life-threatening decompression sickness. Committing a patient to a Treatment Table 7 involves isolating the patient and having to minister to his medical needs in the recompression chamber for 48 hours or longer. Experienced diving medical personnel shall be on scene.

8.7 Treatment Table 8

Treatment Table 8 is an adaptation of a Royal Navy Treatment Table 65 mainly for treating deep uncontrolled ascents (see Volume 3) when more than 60 minutes of decompression have been missed. Compress symptomatic patient to depth of relief not to exceed 225 fsw. Initiate Treatment Table 8 from depth of relief. The Table 8 schedule from 60 feet is the same as Treatment Table 7.

9.0 Record Keeping Requirements:

The employer shall record the occurrence of any diving-related injury or illness, which requires any dive team member to be hospitalized for 24 hours or more, specifying the circumstances of the incident and the extent of any injuries or illnesses.

9.1 Availability of Records

Upon the request of the Assistant Secretary of Labor for Occupational Safety and Health, or the Director, National Institute for Occupational Safety and Health, Department of Health and Human Services of their designees, the employer shall make available for inspection and copying any record or document required by this standard.

Records and documents required by this standard shall be provided upon request to employees, designated representatives, and the Assistant Secretary in accordance with 29 CFR 1910.20 (a)-(e) and (g)-

- Safe practices manuals (1910.420), depth-time profiles (1910.422), recordings of dives (1910.423), decompression procedure assessment evaluations (1910.423), and records of hospitalizations (1910.440) shall be provided in the same manner as employee exposure records or analyses using exposure or medical records. Equipment inspections and testing records which pertain to employees (1910.430) shall also be provided upon request to employees and their designated representatives.
- Records and documents required by this standard shall be retained by the employer for the following period:
- Dive team member medical records (physician's reports) (1910.411) - 5 years;
- Safe practices manual (1910.420) - current document only;
- Depth-time profile (1910.422) - until completion of the recording of dive, or until completion of decompression procedure assessment where there has been an incident of decompression sickness;
- Recording of dive (1910.423) - 1 year, except 5 years where there has been an incident of decompression sickness;
- Decompression procedure assessment evaluations (1910.423) - 5 years;
- Equipment inspections and testing records (1910.430) - current entry or tag, or until equipment is withdrawn from service;
- Records of hospitalizations (1910.440) - 5 years.
- After the expiration of the retention period of any record required to be kept for five (5) years, the employer shall forward such records to the National Institute for Occupational Safety and Health, Department of Health and Human Services. The employer shall also comply with any additional requirements set forth at 29 CFR 1910.20(h).

10. Definitions

"Acfm": Actual cubic feet per minute.
"ASME Code or equivalent": ASME (American Society of Mechanical Engineers) Boiler and Pressure Vessel Code, Section VIII, or an equivalent code which the employer can demonstrate to be equally effective.
"ATA": Atmosphere absolute.
"Bell": An enclosed compartment, pressurized (closed bell) or unpressurized (open bell), which allows the diver to be transported to and from the underwater work area and which may be used as a temporary refuge during diving operations.
"Bottom time": The total elapsed time measured in minutes from the time when the diver leaves the surface in descent to the time that the diver begins ascent.
"Bursting pressure": The pressure at which a pressure containment device would fail structurally.
"Cylinder": A pressure vessel for the storage of gases.
"Decompression chamber": A pressure vessel for human occupancy such as a surface decompression chamber, closed bell, or deep diving system used to decompress divers and to treat decompression sickness.
"Decompression sickness": A condition with a variety of symptoms which may result from gas or bubbles in the tissues of divers after pressure reduction.

"Decompression table": A profile or set of profiles of depth-time relationships for ascent rates and breathing mixtures to be followed after a specific depth-time exposure or exposures.
"Dive location": A surface or vessel from which a diving operation is conducted.
"Dive-location reserve breathing gas": A supply system of air or mixed-gas (as appropriate) at the dive location, which is independent of the primary supply system and sufficient to support divers during the planned decompression.
"**Dive team":** Divers and support employees involved in a diving operation, including the designated person-in-charge.
"Diver": An employee working in water using underwater apparatus which supplies compressed breathing gas at the ambient pressure.
"Diver-carried reserve breathing gas": A diver-carried supply of air or mixed gas (as appropriate) sufficient under standard operating conditions to allow the diver to reach the surface, or another source of breathing gas, or to be reached by a standby diver.
"Diving mode": A type of diving requiring specific equipment, procedures and techniques (SCUBA, surface-supplied air, or mixed gas).
"Fsw": Feet of seawater (or equivalent static pressure head).
"Heavy gear": Diver-worn deep-sea dress including helmet, breastplate, dry suit, and weighted shoes.
"Hyperbaric conditions": Pressure conditions in excess of surface pressure.
"In-water stage": A suspended underwater platform which supports a diver in the water. **"Live-boating":** The practice of supporting a surfaced-supplied air or mixed gas diver from a vessel which is underway.
"Mixed-gas diving": A diving mode in which the diver is supplied in the water with a breathing gas other than air.

"No-decompression limits": The depth-time limits of the "no-decompression limits and repetitive dive group designation table for no-decompression air dives", U.S. Navy Diving Manual or equivalent limits which the employer can demonstrate to be equally effective.
"Psi(g)": Pounds per square inch (gauge).
"Scientific diving" means diving performed solely as a necessary part of a scientific, research, or educational activity by employees whose sole purpose for diving is to perform scientific research tasks. Scientific diving does not include performing any tasks usually associated with commercial diving such as: Placing or removing heavy objects underwater; inspection of pipelines and similar objects; construction; demolition; cutting or welding; or the use of explosives.
"SCUBA diving": A diving mode independent of surface supply in which the diver uses open circuit self-contained underwater breathing apparatus.
"Standby diver": A diver at the dive location available to assist a diver in the water.
"Surface-supplied air diving": A diving mode in which the diver in the water is supplied from the dive location with compressed air for breathing.
"Treatment table": A depth-time and breathing gas profile designed to treat decompression sickness.
"Umbilical": The composite hose bundle between a dive location and a diver or bell, or between a diver and a bell, which supplies the diver or bell with breathing gas, communications, power, or heat as appropriate to the diving mode or conditions, and includes a safety line between the diver and the dive location.
"Volume tank": A pressure vessel connected to the outlet of a compressor and used as an air reservoir.

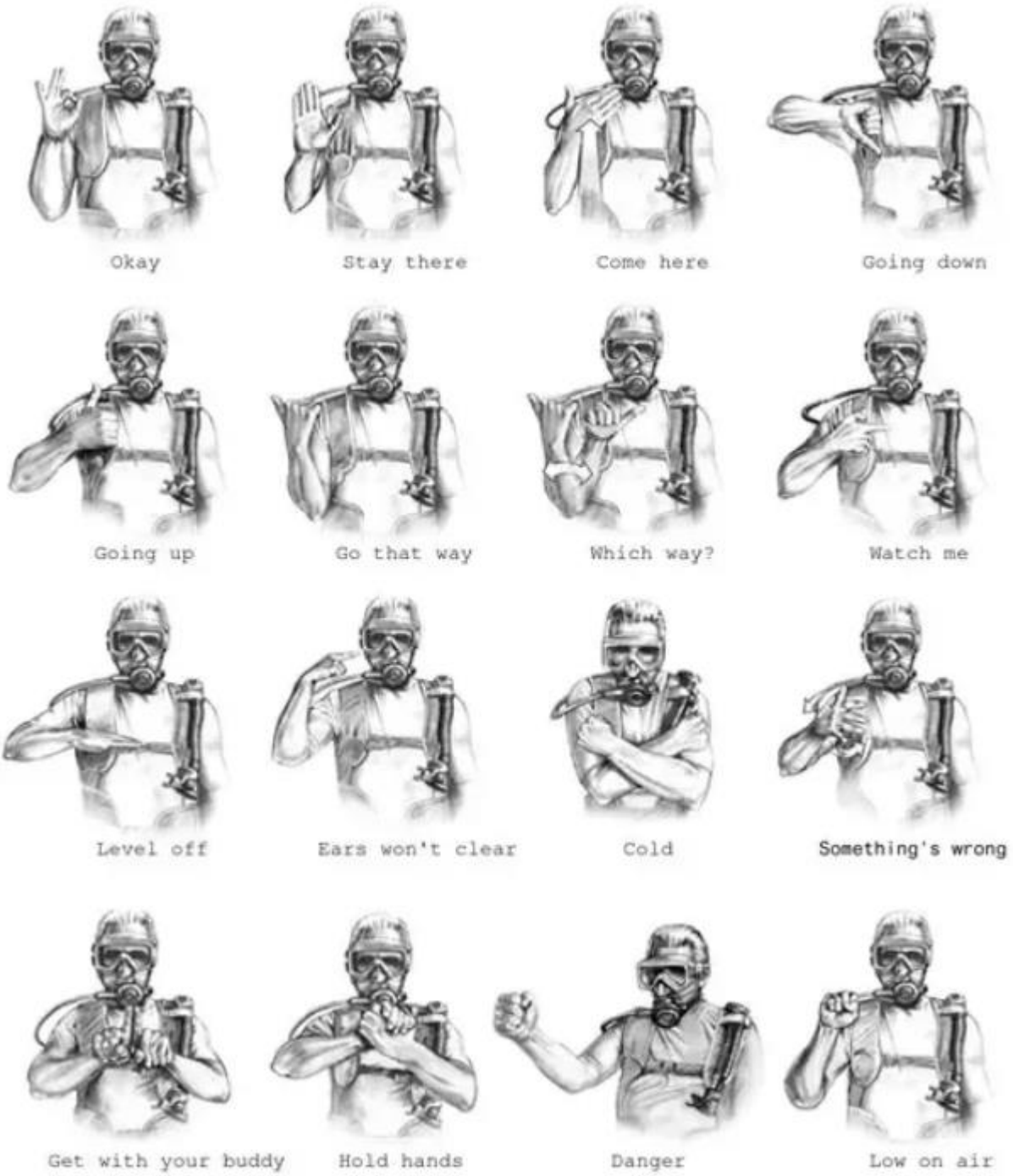
"Working pressure": The maximum pressure to which a pressure containment device may be exposed under standard operating conditions

SURFACE-SUPPLIED PREDIVE CHECKLIST

1. Verify	**Diving Supervisor**	
	Verify that a recompression chamber is available. For all decompression dives and dives deeper than 100 fsw a chamber is required on site. Check First Aid / Stretcher / O2	
	Verify that proper signals indicating underwater operations being conducted are displayed correctly.	
	Ensure that all personnel concerned, or in the vicinity, are informed of diving operations	
	Determine that all valves, switches, controls, and equipment components affecting diving operation are tagged-out to prevent accidental shut-down or activation.	
	Verify that the diver and standby diver are healthy and capable of performing the diving task.	
	Verify that the diving system is aligned properly and determine that sufficient fuel, coolant, lubricants, and antifreeze are available to service all components throughout the operation	
2. Activate the Air Supply	**Tender Perform the following**	
	Secondary Air – Open Air Cylinders verify proper pressure	
	Activate and ensure air through divers umbilical	
	Secure secondary air at divers console	
	Primary Air - Start the compressor check all petcocks, filler valves, filler caps, overflow points, bleed valves, and drain plugs for leakage or malfunction of any kind	
	Check that compressor intake is obtaining a free and pure suction without contamination	
3. Attach the Umbilical	**Tender Perform the following**	
	Blow down the umbilical. Ensure hoses are free of moisture, packing material, or chalk and attach it to the Non-Return Valve.	
4. Hat the Diver	**Tender / Diver Perform the following**	
	Ensure air is on to the hat. Don the hat connect the neckdam	
	Connect EGS to the hat. Ensure EGS cylinder valve is open. Verify EGS valve on hat is in the closed position	
5. Check Communications	**Diver Preform the following**	
	Check Com's	
6. Tender Check the Entire Rig	**Tender Perform the following**	
	a. Soap and leak check the Helmet gas fittings and connections including the EGS	
	b. Check Neck Yoke is properly attached to the helmet and all locking pins engaged	
	c. Check Safety Harness is properly adjusted and in good condition	
	d. Check Umbilical Strain Release	
	e. Check EGS Hose Quick Disconnect	
	f. Check Boots, gloves, knife, tools and other accessories	
	g. Check the hot water supply and connections	
	h. Check the dry suit Inflation Hose Connection. Ensure the dry suit Inflation Valve and Exhaust Valve function properly	

Dive Tender Signature:_____ Date:_____

ADDENDUM # 2


Okay
Stay there
Come here
Going down
Going up
Go that way
Which way?
Watch me
Level off
Ears won't clear
Cold
Something's wrong
Get with your buddy
Hold hands
Danger
Low on air

Caldwell
Marine International

DIVE EQUIPTMENT INSPECTION INTERVALS

Primary Equipment					
Dive Spread #:					
Description:	ID #	Inspection Frequency:	Responsible Party:	Inspection Performed By:	Inspection Date:
Master Cal. Gauge		6 Mo.	CMI		/ /
Pneumo Fathometer		6 Mo.	CMI		/ /
Volume Tank		5 Yr.	CMI		/ /
Volume Tank Gauge		6 Mo.	CMI		/ /
Dive Hoses			CMI		/ /
Dive Compressor (Air)		6 Mo.	CMI		/ /
Deck Whips		6 Mo.	CMI		/ /
Dive Compressor (Gauge)		6 Mo.	CMI		/ /
Diver Helmet		1 Yr.	Diver		/ /
Diver Bail-Out Bottle (Visual)		1 Yr.	Diver		/ /
Diver Bail-Out Bottle (Hydro)		5 Yr.	Diver		/ /
First Aid Kit					/ /
					/ /
					/ /
					/ /

Back-Up Equipment					
Description:	ID #:	Inspection Frequency:	Responsible Party:	Inspection Performed By:	Inspection Date:
Dive Compressor (Air)		6 Mo.	CMI		/ /
Dive Compressor (Gauge)		6 mo.	CMI		/ /
					/ /
					/ /

It this Equipment in Safety Operation Condition? ☐ YES ☐ NO
Provide Detail(s) of any Item(s) of Concern:

Dive Supervisor Review: _____ Date: / /

CaldwellMarine INTERNATIONAL NORTHEAST REMSCO Construction HUXTED TRENCHLESS

‘

Caldwell
Marine International

Certificate of Calibration Verification

Reference Gauge	
Date:	Test Gauge Description:
Accuracy Grade:	Calibrating Date:

Tested Gauge				
Gauge Number:			Gauge Due Date:	
Model:			Accuracy Grade:	
Temperature:	°F	Test Units:	FSW ☐	PSI ☐
Permissible Error % of span:	±1% ☐		(± 2%-±1%-2% ±) ☐	(± 3%-±2%-3% ±) ☐

1st Cycle		
Reference Gauge Up-scale	Test Gauge Reading	In Range
Reference Gauge Down-Scale	Test Gauge Reading	In Range
2nd Cycle		
Reference Gauge Up-Scale	Test Gauge Reading	In Range
Reference Gauge Down-Scale	Test Gauge Reading	In Range

Dive Supervisor Review: _____ **Date:** ___/___/___

CaldwellMarine INTERNATIONAL NORTHEAST REMSCO Construction HUXTED TRENCHLESS