Prepared by:

ERM

Independent Hazard Analysis

Jupiter Drill Break
Tierra del Mar Subsea Cable Landing Site
Tillamook County, Oregon

Peer-Reviewed by:

Geosyntec consultants

28 August 2020

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ERM

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Paul Krause, PhD
ERM Partner

Kim Marcus LG, LEG, LHG
ERM Partner

Nikki Payne, P.E.
ERM Partner

ERM-West, Inc.
1050 SW 6th Ave. Suite 1650
Portland, Oregon 97204

Geosyntec Consultants, Inc, (Peer-Reviewer)
920 SW 6th Ave, Suite 600
Portland, Oregon 97204

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Acronyms and Abbreviations

CFR	Code of Federal Regulations
cm	centimeter
DOGAMI	Department of Geology and Mineral Industry
EC	effective concentration
Edge	Edge Cable Holdings USA, LLC
ERM	ERM-West, Inc.
FOC	fiber optic cable
gal	gallon
Geosyntec	Geosyntec Consultants, Inc.
HDD	horizontal directional drilling
lb	pound
LC	lethal concentration
OCS	Oregon Conservation Strategy
OPRD	Oregon Parks and Recreation Department
OSHA	Occupational Safety and Health Administration
SDS	safety data sheet
TCI	tri-cone

EXECUTIVE SUMMARY

The analysis herein was prepared in response to a drill break that occurred on 28 April 2020, during the drilling operation for the Jupiter subsea cable system in Tierra del Mar, Tillamook County, Oregon. The horizontal directional drilling (HDD) drilling pipe broke, resulting in drill tooling (mostly 6-inch steel) and drilling mud (collectively "Remaining Materials") being left at a depth of 50 to 70 feet below the seafloor, between approximately 1,690 and 520 feet offshore.

In response to the occurrence and follow-up requests from agencies, ERM-West, Inc. (ERM), a global environmental consulting firm, conducted an independent analysis of potential impacts associated with the drill break and leaving the drill tooling and drilling mud (collectively "Remaining Materials") in place, with the following objectives:

1. Identify environmental, economic, recreational, and scenic impacts for consideration by the public, stakeholders, and regulatory agencies.
2. Evaluate the potential options for recovery of the Remaining Materials and environmental, economic, recreational, and scenic impacts of each.

ERM's analysis concludes that there are currently no adverse environmental, scenic, recreational, or economic impacts resulting from the drill break or presence of Remaining Materials 50 to 70 feet below the sea floor, nor is there a reasonably conceived scenario (e.g., earthquake, tsunami, long-term coastal erosion) that would expose the Remaining Materials to the surrounding environment and result in future impacts. For this reason, the recommended environmentally-preferred alternative is to leave the Remaining Materials in place. The following summarizes the conclusions of this analysis:

- The drilling mud has presumably hardened and is effectively encasing the drilling materials trapping additive constituents and limiting movement or migration within the surrounding sediment and rock.
- The buried drilling components are solid metal pieces that will corrode in place over time at a very slow rate given the low levels of oxygen and seawater at such depths; this oxidation process will create a hardened shell around the metal, which is surrounded by mud; migration would be negligible.
- The lithology (e.g., sediment) surrounding the Remaining Materials provides an additional layer of migration prevention with a minimum 50 foot buffer between the Remaining Materials and the biologically-active benthic zone or seafloor. This depth of burial essentially eliminates any ecological or public risks associated with leaving the Remaining Materials entombed in the seafloor strata.
- There are no mapped seismically active faults intersecting the Remaining Material that would pose a risk for severing or displacing the drilling equipment. Based on the gradual slope of the seafloor, the predicted locations for submarine mass-movements would be at least 6 to 10 miles west of the Remaining Materials.
- Based on Federal Emergency Management Agency (FEMA) tsunami observations, scour depths near the Landing Site are estimated to be fewer than approximately 10 feet; therefore, they do not impose a risk to uncovering the Remaining Materials in the event of a tsunami.

Regarding recovery options, using HDD to recover the Remaining Material is a nonviable option given the extremely low probability of success, as the drill bit would need to perfectly align with the 6-inch bore pipe 520 feet from shore. The second option of dredging from the seafloor would result in extensive environmental impacts from sediment excavation, anchoring, and using vessels and barges over a 2-month period. The environmentally preferable option, and one with no perceived scenic, recreational, or economic impacts, is the "No Action" alternative to leave the Remaining Materials at a depth of 50-70 feet below the seafloor.

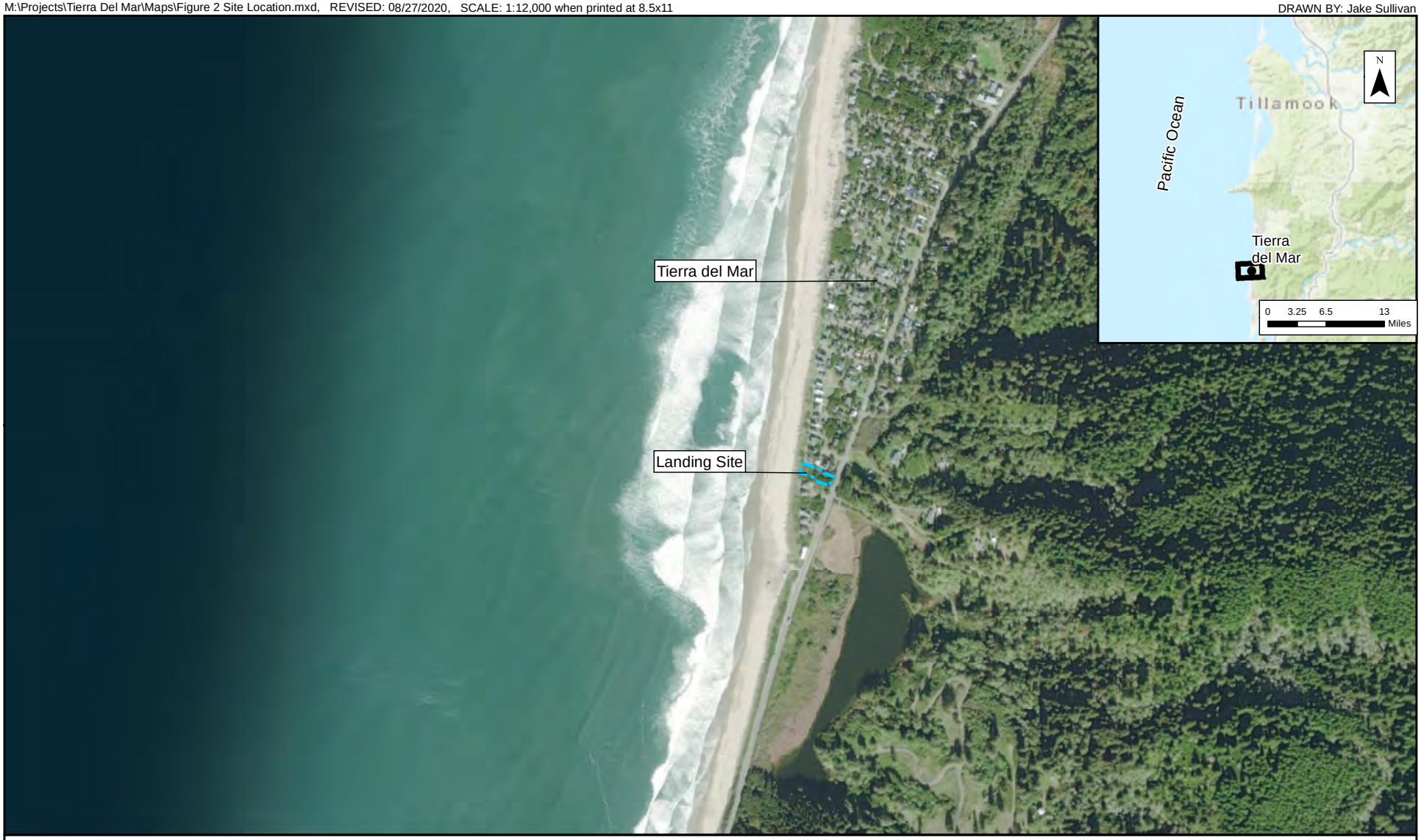
1. INTRODUCTION

In March and April 2020, Edge Cable Holdings USA, LLC ("Edge") and its subcontractor SubCom (and horizontal directional drilling [HDD] subcontractors Maritech and Carson Corporation [Carson]) conducted an HDD operation to install a sub-oceanic steel bore pipe from Lot 3200 in Tierra del Mar ("Landing Site"; Figure 1; Photo Log, Appendix B), Tillamook County, Oregon, for the installation of the Segment 2 branch of the international subsea Jupiter telecommunications cable ("Jupiter Project").

On 28 April 2020, during the drilling operation and 500 feet from the exit point, the HDD drilling pipe broke, resulting in drill tooling and drilling mud (collectively "Remaining Materials") being left at an average depth of approximately 50 feet below the seafloor between approximately 1,690 and 520 feet offshore, as described further below.

In response to the occurrence and follow-up requests from agencies, ERM-West, Inc. (ERM), a global environmental consulting firm, has conducted an independent analysis of potential impacts associated with the drill break and leaving the Remaining Materials in place, with the following objectives:

1. Identify environmental, economic, recreational, and scenic impacts for consideration by the public, stakeholders, and regulatory agencies.
2. Evaluate the potential options for recovery of the Remaining Materials and environmental, economic, recreational, and scenic impacts of each.



Legend

Landing Site

N

0 500 1,000 2,000
Feet

Figure 1
Landing Site Location
Tierra del Mar
Tillamook County, Oregon

Environmental Resources Management
www.erm.com
ERM

Source: Esri - World Topoographic Map; NAD 1983 StatePlane Oregon North FIPS 3601 Feet

1.2 Overview of Analysis

ERM's team of Subject Matter Experts (presented below in Section 1.3) determined that the following elements would be analyzed to evaluate the likelihood and extent of environmental, economic, recreational, and scenic impacts associated with the drill break and current and future status of the f Remaining Materials:

- Current location of the Remaining Materials and the nature of the surrounding substrate based on drilling logs and review of localized geology
- Drilling mud volume, composition and toxicity potential based on mud reports, Safety Data Sheets (SDS), and prior analysis conducted by ERM regarding bentonite mixtures in the marine environment
- Migration potential for drilling mud and drill tooling components within existing substrate over time
- Potential for Remaining Materials to contact the biotic horizon or onshore environment
- Stability and potential for movement of the Remaining Materials during a seismic or other geologic event

ERM also provides an analysis of environmental impacts associated with two identified possible recovery options. Geosyntec Consultants Inc. (Geosyntec) provided an independent peer review of ERM's Hazard Analysis for the Jupiter Drill Break (Appendix A). Based on their experience and technical backgrounds, it is Geosyntec's professional opinion that the conclusions of the analysis presented relative to the sections reviewed are sound and supported by relevant science.

1.3 Credentials of Preparers

- **Paul Krause, PhD (ERM):** Dr. Paul Krause is Partner at ERM located in Marina del Rey, California. He is an internationally recognized expert with 30 years of experience in marine ecology and toxicology specializing in issues related to the effects of industrial developments. His particular expertise revolves around marine ecological issues, toxicology (including sediments), and the effects of discharges on marine populations and communities. He has served in emergency response to drilling accidents and releases, as well as developing response plans for spills throughout the world. He has a PhD in Ecology and is a Certified Professional Ecologist and active member of the Ecological Society of America, Society of Petroleum Engineers, and the Society of Environmental Toxicology and Chemistry. Dr. Krause has authored numerous peer-reviewed publications and book chapters and served as a litigation expert for spills and discharge issues.
- **Kim Marcus LG, LEG, LHG (ERM):** Mr. Kim Marcus is an Oregon-based Geologist with 45 years of experience in geology, marine geology, and geotechnical studies for the US Geological Survey and as a consultant. He also manages hazardous waste cleanups involving local, state, and federal investigations and remediation projects that involve CERCLA, RCRA, TSCA criteria and requirements. While at the US Geological Survey, he assessed and mapped marine sediment along shorelines in Washington and Oregon looking for active faults. He has performed offshore and near-shore drilling for geotechnical projects, assessed continental shelf shorelines along the west coast of the United States from the Canada to Mexico, mapped coastal zone areas, and worked on many other marine projects. He is an author and editor of two books: "Environmental, Groundwater and Engineering Geology: Application from Oregon" (1998) and "Engineering Geology in Washington – Bulletin 78" (1989). In Bulletin 78, he was chapter editor and author on "Coastal and Marine Engineering Geology." He has given testimony on behalf of the United States in Federal Court on marine issues associated with development on a National Wildlife Refuge.
- **Nikki Payne, PE (ERM):** Ms. Nikki Payne is an Impact Assessment practitioner and Environmental Engineer with 15 years of experience in environmental consulting and preparation of extensive

impact assessments and permitting applications. She has successfully permitted and overseen the installation of two subsea cable systems, working closely with state agencies on HDD release contingency plans.

The GeoSyntec peer review was conducted by:

- **Tony Rice, P.E.:** Tony is a senior geotechnical engineer and a subject matter expert in HDD with more than 35 years of consulting experience. He has worked on HDD drilling projects in the Oil & Gas pipeline industry and Telecommunications sector since 1988. His expertise includes HDD feasibility evaluations, HDD designs, troubleshooting HDD projects for owners and contractors, and conducting forensic evaluations for problematic HDD projects. He has worked on HDD projects throughout North America, South America and Asia.
- **Lance Fontenot, Ph.D., PWS:** Lance is an Environmental Toxicologist with over 25 years of experience specializing in assessing the human health and ecological effects of hazardous substance releases. His experience includes ecological risk assessments, wetland assessments, biological assessments, and impact assessment of aquatic species and habitats.
- **Sean Ragain, R.G.:** Sean is an Oregon Registered Geologist with more than 30 years of professional consulting. Sean's diverse experience includes conducting environmental investigations onshore and offshore in the USA and internationally.

2. BACKGROUND

This section provides a description of a typical HDD drilling operation, a summary of the pipe break incident including the composition of the downhole drilling fluid (referred to herein as "mud") and Other Remaining Materials (mostly 6-inch steel pipe), and a brief background of the surrounding environment and geology. The HDD description is specifically focused on the type of drilling employed for the Jupiter Project.

2.1 Description of Typical Drilling Operation

HDD technology allows for the installation of underground utilities with minimal impact on the surface. One application of HDD is to install fiber optic cable (FOC) for telephone and internet as well as other cables. The HDD process is described in general terms below.

HDD uses a drill bit that enters the ground (entry point or punch-in) at a slight downward angle to develop a bore through the ground. The angle is progressively adjusted to the horizontal when the bore reaches the desired depth, and is then turned upward to reach a pre-defined point (exit-point or punch-out). For the bore to remain open as the bit and drill pipe moves forward, drilling mud is pumped from the drill rig, down inside the drill string, exits the drill bit and carries suspended rock and soil cuttings in the annulus between the drill string and the bore wall. The drilling mud returns to mud tanks near the drill rig where rock chips sand and silt size cuttings are removed and the drilling mud is recycled back into the pipe. The drilling mud is reused many times but needs to be supplemented as the holes get longer and the mud remains in the hole as a lining and lubrication for the bore pipe.

When an FOC HDD bore is complete, there are several options for installation of the required cable. The Jupiter Project adopted the "Drill & Leave" steel pipe installation method, which is industry standard for subsea cable installations along the western coast of the United States to avoid beachfront impacts. In a normal Drill & Leave installation, once the drill bit and bore pipe surface at the end, the drill bit is removed. This process leaves the drill string in place; a smaller diameter conduit (or conduits) is then sometimes pulled into place and the FOC is pulled through the bore pipe (or conduit[s]) back to the landing location. In this case, the inside of the drill string was coated to facilitate cable installation and conduit (s) were not used. The following describes the physical components of the HDD process:

- Horizontal Directional Drilling Rig – The three main functions of an HDD rig are rotation, forward thrust, and pullback of the drill rod. Before drilling commences, the HDD rig is positioned to align with the proposed surveyed bore path.
- Drill Pipe (also drill stem, joints, drill string, drill rod) – Drill pipe is hollow and allows pressurized fluids (drilling mud) to circulate from the drill rig to the drill head, where the mud is expelled from jetting nozzles. Drill rods, which are nominally 40 feet long and are screwed together, are composed of specially formulated steel capable of withstanding the tensional, compressional, and torsional forces experienced during the drilling process. HDD drilling rods specifically must accommodate the forces listed above in addition to the forces created by bending through the proposed bore path.
- Steel Casing – In this and many other cases, a casing was installed, through which the drill pipe runs, to prevent the bore from extensive collapse (the start and end positions of the casing in the bore are decided upon commencement of the pilot bore). The steel casing effectively crosses the areas of collapse, enhancing the drill mud returns and reducing friction on the drill pipe.
- Drill Heads (also drill bit or cutting head) – The drill head advances into the subsurface by pushing and rotating the drill head and drill pipe. The thrust and rotation cut the formation (soil and/or rock) with the help of the pressurized mud spraying from jets in the drill bit, excavating a borehole the diameter of the cutting head. To "steer" the drill head, rotation of the drill string is discontinued and

the drill rods are pushed forward. The slight bend in the pipe (i.e., bent sub) between the drill pipe and the drill bit forces deflection of the drill head from the original path in the direction the bend is pointed. To accomplish this steering, the location and orientation of the drill head must be known—see locating techniques below.

The cutting head (drill bit) is chosen based on the geologic formation encountered. Soft formations often require a mill-tooth bit and hard formations benefit from a tri-cone (TCI) bit. Both bits were used in the course of the Jupiter Project. When conducting directional drilling using a mill-tooth or TCI bit, a mud motor is used to increase torque and rotate the cutting head independent of drill string rotation to steer while drilling. Rotation of the mud motor is induced by the drilling mud flowing through it. There is a short segment of drill stem with a bend (bent sub) between the mud motor/bit assembly and drill stem. The orientation of the bend in the bent sub directs the travel of the drill head.

- Locating and Directional Techniques – Steering tools (including a steering tool and gyro module) are a type of locating technology that provides real-time location and orientation (telemetry) of the drill head for accurate steering. Telemetry data are transmitted from the steering tools, installed behind the drill head/mud motor/bent sub, to the drill rig through a wire in the drill stem. The telemetry data are recorded to map the progress of the pilot bore.
- Drilling Mud – HDD drilling mud is a water-based mixture of naturally occurring bentonite (and other additives discussed below [e.g., Platinum D-D, Wyo-Vis DP®, Soda Ash, Sand Force]) used to cool the drill head, support the bore, and remove cuttings from the borehole. The drilling mud mixture should suspend solids, flow easily, maintain the bore, and lubricate the conduit during installation.
- Mud Mixing / Recycling Unit and Water Supply – A recycling unit is employed to reuse the drilling mud exiting from the drill entry point during the pilot bore formation, optimizing the use of bentonite, additives and fresh water for the mixing. The recycling unit is placed near the water supply connection, settlement tank returns (excess cuttings), and high-pressure mud pump paired to the drill rig.
- High-Pressure Mud Pump – A high-pressure mud pump is employed to facilitate feeding drilling mud to the HDD rig from the drilling mud recycling unit, for efficient drilling operations.

The last segment of a pilot bore drilled prior to exiting the seafloor is free of drilling mud, with fresh water being fed in the bore to flush out drilling mud and ensure no mud escapes the bore at the punchout position.

2.2 Summary of Incident and Remaining Materials at Drilling Site

2.2.1 Incident Description

According to the Incident Report provided to ERM, on 28 April 2020 at approximately 2:30 p.m. Pacific Daylight Time, drilling activities at the Jupiter Project Landing Site were halted due to a 6-inch steel drill-pipe joint failure. While advancing the pilot bore, Carson observed a loud noise preceding the failure. Immediately following, a loss of drilling mud pressure to the drill bit and a loss of power to the steering tools were observed. At the time of the drill pipe break, approximately 1,691 total feet had been drilled, with approximately 6 feet remaining on Joint #53 (the joints are each approximately 31.9 feet long). Additionally, 240 feet of 16-inch, outer-diameter steel bore casing was in the ground from the bore entry point.

According to the Incident Report, upon recognition of a drill-pipe joint failure, the drill crew recovered the downhole drill string still connected to the drill rig, along with approximately 240 feet of steel bore casing.

According recovery effort records, the failure occurred approximately 7.5 feet beyond Joint #15. Approximately 1,170 feet of 6-inch steel drill pipe, including the drill bit head, were not recovered and remained within the borehole.

Based on ERM's independent review of the drilling logs and telemetric data, it was verified that the Remaining Materials are located at a depth ranging from approximately 50 to 70 feet below the seafloor. A chart depicting the path of the borehole relative to the ground level (beach and seafloor) is included below as Figure 2.

As the drill stem was removed, the surrounding lithology would have collapsed into the void almost immediately encasing the mud and preventing movement from beyond the bore hole.

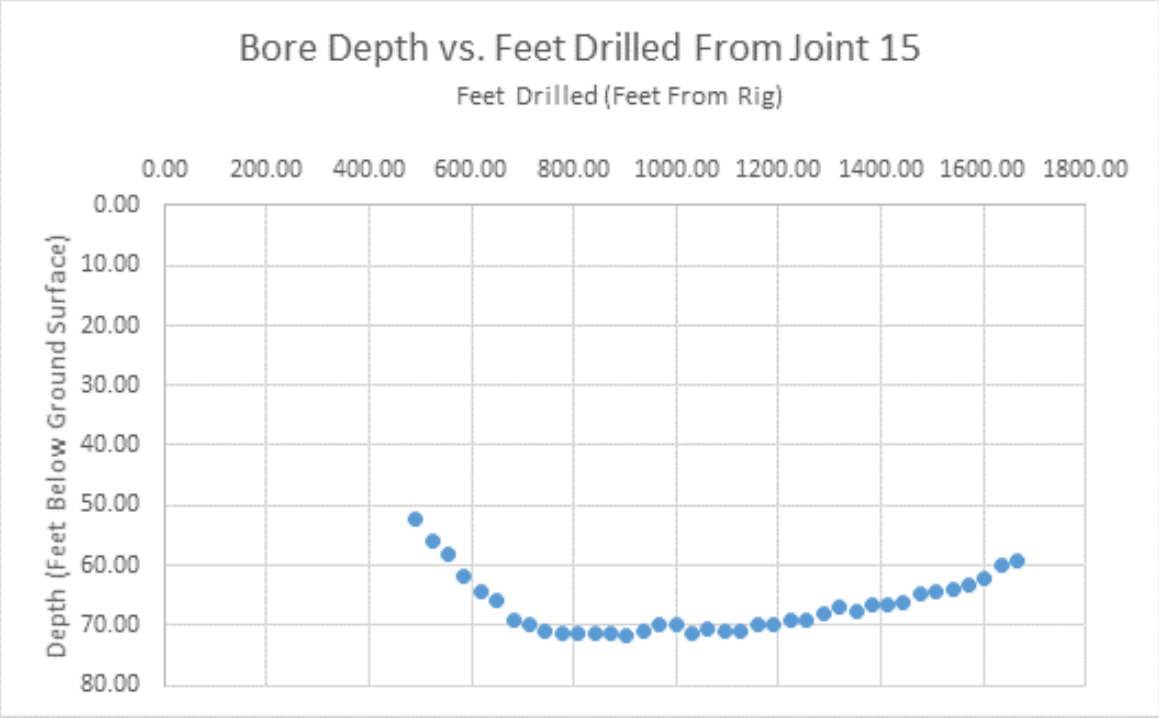


Figure 2: Depth of Remaining Materials

2.2.2 Incident Response

According to the Incident Report provided to ERM, the drill crew developed a plan to recover the drill pipe and drill head assembly, which remained downhole. However, the drill crew determined that the only way to attempt to recover the drill head assembly was to procure and install an additional 400 feet of 24- to 32-inch bore casing (as the drill head assembly was well beyond the end of the existing 16-inch bore casing), as well as procure and install a ball-grab assembly (which was not immediately available on site).

Based on those considerations and to remain in compliance with the Tillamook County-mandated construction timeline ending on 30 April 2020, the decision was made to stop all construction activity on 29 April 2020 and commence demobilization from Lot 3200.

2.2.3 Drilling Mud Composition

According to the mud reports from 28 April 2020 (which were comparable to mud composition on prior days), the drilling mud used was fresh-water-based and included the following naturally occurring bentonite and additives (see Appendix C for Mud Report and further details in Section 3.1):

- Super Gel-X® (bentonite)
- Wyo-Vis DP® (water soluble polymer)
- Sand Force (grit)
- Soda Ash (binds calcium ions)
- Platinum D-D (lubricating solution)

2.2.4 Other Remaining Materials

The following is a list of Other Remaining Materials in the pilot borehole (further details in Section 3.1):

- Approximately 1,170 feet of 6-inch steel drill pipe with TK™-34P, an internal epoxy coating
- A telemetry cable for power to the bit
- A tungsten carbide drill head (bit)
- A non-magnetic drill collar, or Monel
- A ParaTrack (guidance system) probe
- A ParaTrack Gyro Module
- A jetting module (i.e., mud motor)

2.3 Surrounding Environment and Geology

2.3.1 Geology

Tierra del Mar, Oregon is located within the greater Cascadia subduction zone convergent plate boundary, spanning from southern British Columbia in Canada to Northern California. The Cascadia region, as with subduction zones elsewhere, has the potential for seismically induced primary (e.g., large-scale earthquakes) and secondary (e.g., landslides, liquefaction of sediment, tsunamis) geologic hazards (i.e., geo-hazards).

The HDD work area is west of the Oregon Coast Range physiographic province, which principally consists of a long, narrow belt of mountains and coastal headlands. The province is composed of volcanic basement rocks (basalt) underlying marine sedimentary bedrock that has been intruded by lava (which makes up the many offshore islands called “haystacks” – such as the one at Pacific City). These haystacks can protrude above the water or have been eroded by the ocean and are present below the water or below the seafloor. The current coastal geomorphology has been shaped by ocean waves, precipitation-induced erosion, mass wasting events (i.e., landslides), and major rivers down-cutting through the mountains and hills to the Pacific Ocean.

Within the drilling pathway, there are former dune sands in the nearshore environment which overly the basalt and/or sandstone discussed above. According to the drilling logs, the last 90 feet of the drill was through rock material. The shallow seafloor in this area is composed of soft sediments, specifically sand, which slopes gently away from the beach (Luce 1927, CEOAS Active Tectonics Lab 2018).

2.3.2 Natural Resources

The shallow seafloor overlying the Remaining Materials t is dominated by benthic invertebrates, which tend to reside either in the substrate (i.e., infauna) or on the substrate (i.e., epifauna) (Oregon Conservation Strategy [OCS] 2020a). Infauna found in Oregon subtidal soft bottom habitats include polychaete worms, mollusks, echinoderms, and crustaceans. Epifauna commonly observed in Oregon subtidal soft bottom habitats include sand dollars, shrimp, crabs, bivalves, snails, sea cucumbers, and some species of benthic fish (e.g., flatfish, Pacific sand lance, sandfish). Specifically, Dungeness crab are often observed along the Oregon coast, either on the seafloor surface or buried in the sand (OCS 2020a). These types of soft sediment organisms are expected in the offshore portions of the site.

Closer to the beach, the increased wave action results in less suitable habitat for large or fragile surface dwelling organisms. However, small organisms such as worms, mollusks, crustaceans, diatoms, copepods, and amphipods can be found in the sand in these environments and are expected to be present at the site (OCS 2020b).

Hard bottom habitats are areas underlain by rock or man-made structures that can provide substrate for organism attachment and outcrops, and serve as habitat areas for motile organisms. However, the Landing Site was chosen after consultation with the Oregon Fishermen's Cable Committee to avoid offshore rocky reefs and sensitive commercial fishing grounds (Oregon State Parks 2019). The closest mapped rocky reef habitat is approximately 2 kilometers offshore the Project site (CEOAS Active Tectonics Lab 2018). Therefore, no rocky reef habitat is expected at the site.

Planktonic communities make up the primary trophic level of marine ecosystems. The taxonomy derived from these organisms is subject to distribution and dispersion based on ambient conditions such as currents, wind, availability of nutrients, light, and sources of food. Plankton groups include phytoplankton, zooplankton, or other groups of animals also subject to ambient dispersion such as ichthyoplankton, eggs, larvae, small crustaceans, mollusks, jellyfish, or other semi-motile invertebrates.

The US Army Corps of Engineers performed an Endangered Species Act consultation during the initial permitting of the Project. During that consultation, it was determined that 17 listed species have the potential to be present in the vicinity of the site, but are not predicted to be jeopardized by the Project. The Oregon Parks and Recreation Department (OPRD), in consultation with the Oregon Department of Fish and Wildlife, indicated that there were no listed species known to inhabit the site (Oregon State Parks 2019). Additionally, because the site is sandy, soft bottom habitat, there is not expected to be suitable habitat for these species. Therefore, any presence of these listed species is likely to be brief and transient.

2.3.3 Water Quality

At the time of writing, no known water quality concerns exist in the vicinity of the Landing Site and localized offshore area, based on the Oregon Health Authority (2020), which lists the nearby Neskowin Beach as "open," meaning swimming and bathing are permitted.

The site is part of the California Current, with seawater generally moving from north to south along the coast (Luce 1927). Additionally, the site will experience influxes of freshwater from Sand Creek, approximately 1 mile north of the site, especially during large precipitation events.

The site is exposed to open ocean wave action from the west, which results in turbidity and resuspension of the local sediments.

3. IMPACT ANALYSIS OF REMAINING MATERIALS

3.1 Water Quality and Natural Resources

The potential natural resources in this region of the offshore environment include those flora and fauna described in Section 2.3.2.

There are “no reports of rare, threatened, or endangered species of fish or wildlife at the site” according to Oregon State Parks (2019). However, salmon species and Southern Resident DPS killer whales may be transiently present at or near the site.

Benthic organisms, which include organisms living on or in the seafloor sediments, are the organisms that are located closest to Remaining Materials (Kingston 2001). The benthic community in this zone consists of large, visible organisms, such as bivalves, polychaete worms, and echinoderms, as well as small, invisible organisms such as amphipods, diatoms, and dinoflagellates (OCS 2020a, b). On average, approximately 95 to 99 percent of the benthic community resides within the first 5 centimeters (cm) of the sediment surface due to competition for limited space to reach oxygenated water and food resources (Kingston 2001). There is variability in the depth of the benthic zone, depending on the study, with some researchers finding the majority of the benthic community within the first 2 cm (Blake 1994) to 15 cm (Johnson 1967). With the local wave action and currents at the site, there is likely to be a greater saturation depth of oxygenated and nutrient-containing water as the sediments are moved around, meaning a greater depth of the benthic zone. However, it is still unlikely that this benthic zone extends further than 3 to 5 feet below the sediment surface. Therefore, there would conservatively be a minimum of 45 feet between the Remaining Materials and benthic natural resources limiting the potential for impacts to benthic organisms.

3.1.1 Toxicity Potential

3.1.1.1 Drilling Mud

Based on calculations using the diameter of the borehole, its length, and the size of the bore pipe, it was determined that approximately 6,500 to 6,700 gallons (gal) of drilling mud was entombed in the borehole when the bore pipe snapped on 28 April 2020. Based on the mud reports for 28 April 2020, it was determined that the drilling mud on the day of the break consisted of 195 bags (50 pounds [lb] each) of Super Gel-X® (i.e., the bentonite mixture), 0.5 gal of Platinum D-D (i.e., a lubricating solution), 4 lb of Wyo-Vis DP® (i.e., a water soluble polymer), 4 lb of Sand Force (i.e., a grit), 4 lb of soda ash, which is used to bind calcium ions, and enough water to mix these additives into a mud of the necessary density for drilling (SDS; Appendix D). The additives contained in the drilling mud are commonly used for HDD projects.

Below is a conservative comparison of the estimated drilling mud concentrations to ecotoxicity levels. Please note that this comparison is hypothetical. It does not represent an actual drilling mud exposure scenario because a release to the benthic zone and water column has not occurred and is not expected to occur based on current site conditions (Section 3.1.2). This hypothetical assessment was performed on the drilling mud to understand potential ecological hazards of the mud itself, in place and in the borehole.

The federal Occupational Safety and Health Administration (OSHA) requires that every chemical manufacturer provide an SDS for each produced chemical or mixture of chemicals. The SDS is required to provide information on potential ecological and human health hazards from the mixture and from each of its constituent parts, if any hazards are known. For example, the SDS for Super Gel-X® provides an assessment of the environmental hazard potential of Super Gel-X® and also provides ecotoxicity information for each of the four chemicals that, when combined, create Super Gel-X®.

The SDS for each additive in the drilling mud was initially examined for potential ecological hazards from the whole chemical or chemical mixture (e.g., Super Gel-X® instead of the constituents of Super Gel-X®). The SDS for Super Gel-X®, Platinum D-D, Wyo-Vis DP®, Soda Ash, and Sand Force all indicate that these products are not environmentally hazardous (CETCO 2015, MiSWACO 2015, Right Turn Supply 2015, Wyo-Ben, Inc. 2015, Right Turn Supply 2018). Based on these statements in the additives' SDS, it was determined that each additive is not expected to result in ecotoxicity hazards to the natural resources or ecological receptors at the site if left in place.

The SDS for each material also contains information on potential hazards to humans. The information applies to the materials in their unused and unmixed state. Super Gel-X®, Wyo-Vis DP®, Sand Force, and Soda Ash are solids, and Platinum D-D is a liquid. The main hazards of these materials prior to mixing are inhalation of dust of the solid materials and eye or skin irritation or damage from Platinum D-D in pure form. Soda ash in pure form may be a skin irritant (with prolonged contact) and a severe eye irritant. None of the constituents are known carcinogens or reproductive toxins. Because the components have been mixed together and are now solidified 50 to 70 feet beneath the ocean floor, any exposure to humans is unlikely, and the potential effects of human exposure to the individual components are not applicable (see Section 3.1.2 for migration potential). Even if the mixed and solidified material did emerge into the nearshore environment where people are swimming or surfing, the hazards of the individual constituents have been neutralized through mixing and solidification.

Some of the additives included in the drilling mud were composed of mixtures of chemicals. To ensure all chemical constituents were examined, the individual chemical constituents of each additive were examined for ecotoxicity to the natural resources at the site (Toxicity Table; Appendix E). The SDS for each additive product lists the constituent chemicals and their percentage of the total mixture in that product. Using the percentage of each additive constituent and the amount of each additive added to the 6,700 gal drilling mud on 28 April 2020, it was possible to calculate the concentration of each chemical constituent for each additive in the drilling mud (Appendix C). This concentration in the drilling mud was then compared to the lowest (i.e., most-conservative) ecotoxicity concentration for that constituent available for an aquatic species in the SDS.

Again, it should be noted that this conservative comparison of the estimated drilling mud concentrations to natural resource ecotoxicity levels is hypothetical and does not represent an actual exposure scenario, as a release to the benthic zone or water column has not occurred and is not expected to occur.

The lowest-available toxic concentrations to aquatic organisms provided in the SDS were either the lethal concentration at the 50 percent level (LC_{50}; i.e., the concentration that produces a lethal response to 50 percent of the test organisms during the observation period) or the effective concentration at the 50 percent level (EC_{50}; i.e., the concentration that induced a toxic response at the 50 percent level) values. The lowest available toxic concentration to an aquatic organism was chosen for each constituent in order to be conservative regardless of whether the aquatic organism was freshwater or marine. If the concentration of the constituent was below the lowest toxic concentration for a given species, there was confidence that the constituent would not be toxic to any species with a higher toxic concentration.

The bentonite clay in the Super Gel-X® was treated slightly differently than the other constituents in Super Gel-X® due to being almost insoluble in water (CETCO 2015). For bentonite, the solubility of the Super Gel-X® chemical mixture was used as the concentration of bentonite in the drilling mud. This solubility represents the maximum concentration of bentonite possible in the drilling mud, although the actual concentration of bentonite in the drilling mud is likely much lower due to the insolubility of bentonite.

The comparison of the additive constituents to their toxic concentrations showed that the concentration in the borehole of all but one constituent was below their associated toxic thresholds (Appendix E). The constituents in Super Gel-X®, Platinum D-D, Wyo-Vis DP®, Sand Force, and Soda Ash were all below

toxic thresholds. The only constituent with concentrations above a toxicity threshold in the borehole was the proprietary product within the Super Gel-X® additive. However, this toxicity threshold is based on aquatic release of the chemical directly to the water column (i.e., seawater), which is not known to have occurred at the time of drilling and is not expected to occur based on the discussion of migration potential below. Additionally, it must be emphasized that the proprietary product comprises only 0.1 percent of the Super Gel-X®, which corresponds to 0.0015 lbs/gal of drilling mud, and only exceeds toxicity thresholds at the concentration present in the bore hole. The driving factor in determining ecological risk is the exposure route to ecological receptors. There is simply no conceivable exposure route for the small concentration of the proprietary product in Super Gel-X to provide ecological exposure, and therefore potential risk to natural resources, in the current location entombed within the HDD borehole at a depth of 50 to 70 feet (Section 3.1.2) to 70 feet (Section 3.1.2).

3.1.1.2 Other Remaining Materials

When the bore pipe broke on 28 April 2020, approximately 1,170 feet of steel bore pipe with TK™-34P internal coating could not be recovered and remains in the borehole, along with all the drilling components, collectively referred to as the Other Remaining Materials. The drilling components remaining in the bore hole include the telemetry cable for power, tungsten carbide drill head, the monel, the ParaTrack probe, the ParaTrack Gyro Module, and the jetting module (i.e., mud motor). As noted for drilling mud, these materials are also expected to be entombed by the hardened bentonite at a depth of 50 to 70 feet below the benthic zone, thus ecological exposure is not conceivable (Section 3.1.2). However, a brief discussion of each component in the Other Remaining Materials and the potential toxicity of any pieces of the components while in the borehole is provided.

The bore pipe is composed of S-135 steel, which is classified as a non-hazardous solid metal article under OSHA Hazard Communication Standard, Title 29 of the Code of Federal Regulations (CFR) Part 1910.1200 (United States Steel Cooperation 2014). Additionally, the steel pipe has a TK™-34P internal plastic coating for corrosion protection, which is not expected to be exposed to the surrounding environment (National Oilwell Varco 2020). Therefore, the presence of the bore pipe in the borehole, which was going to be present at this location regardless of the drilling outcome to hold the Jupiter cable, is not expected to present ecological hazards.

The drill head is a solid tungsten carbide alloy tip used for drilling through various types of rock and sediments. This drilling head tool is non-hazardous under the OSHA Hazard Communication Standard 29 CFR 1910.1200 criteria (Rock River Tool, Inc. 2004). Therefore, the presence of the drilling head in the borehole is not expected to present ecological hazards.

The monel is a collar used to isolate and shield the drilling instruments from the electromagnetic field produced by the drill head during the drilling process. Monel are nickel alloys, composed of nickel, copper, iron, manganese, carbon, and silicon, all of which are naturally occurring in marine sediments. SDS of typical monel produced by various companies all indicate that, as a solid object, which the monel in the borehole is, there is no ecotoxicity hazard from this component and it is not expected to present an ecological hazard (Special Metals 2011, Doncasters 2015). Additionally, no hazardous decomposition products are formed when the monel begins to decompose, based on the SDS, indicating no potential ecological hazards to natural resources over time (Special Metals 2011, Doncasters 2015).

A ParaTrack probe was used as the steering module during the HDD operations and is still present in the borehole. An additional steering component, the ParaTrack Gyro Module, is also still present in the borehole. These components contain beryllium copper alloy 25 and steel alloys N60 and 303, which have SDS provided by the manufacturer (ThyssenKrupp Materials NA, Inc. 2014, Materion 2018). Additional constituents in the probe and gyro modules are not provided by the manufacturer. However, the probe and gyro modules likely contain computer chips and some plastic or rubber components. Regardless of

the additional components, the vice president of Vector Magnetics, the manufacturer of the ParaTrack probe and gyro modules, has stated that these two tools have been manufactured in compliance with the SDS (ThyssenKrupp Materials NA, Inc. 2014, Materion 2018), they are stable and non-reactive under normal conditions, and no ecotoxicity is known for the components of either module (Vector Magnetics 2020).

The jetting module is composed of annealed tool steel and rubber, based on previous experience with these components. Steel, which is classified as a non-hazardous solid metal article, is not expected to present ecological hazards when left in place (United States Steel Cooperation 2014).

3.1.2 Migration of Material

3.1.2.1 Drilling Mud

The drilling mud is composed of soluble (i.e., dissolvable) and insoluble (i.e., undissolvable) chemical constituents. For example, Wyo-Vis DP is a polymer that dissolves in water, whereas the quartz in Super Gel-X will remain as a particle suspended in water.

The SDS for Super Gel-X states that bentonite is almost insoluble and will not migrate in sediments (CETCO 2015). One of the unique properties of bentonite is that it reacts as a mud when it is under continuous mechanical stress, such as when it is used as a drilling mud. However, when the mechanical stress is removed, bentonite hardens (Grolms 2015). Therefore, when left in place in a borehole, the drilling mud hardens into a shell surrounding the bore pipe, effectively entombing the chemical constituents of each additive in this hardened drilling mud tube. This is what was expected to occur to the completed Jupiter borehole, with the hardened drilling mud tube providing stability and protection for the bore pipe. The existing borehole is currently located at a depth of 50 to 70 feet below the seafloor and has experienced no continual mechanical stress that would keep the bentonite in liquid form. Thus, the drilling mud has likely hardened as expected for the completed borehole, trapping all constituent chemicals, 50 to 70 feet below the seafloor and greater than 45 feet below any potential natural resources in the benthic zone.

If any of the insoluble additive constituents were to migrate, which is not expected based on their chemical compositions and containment in the hardened drilling mud, it is expected that these constituents would be very fine-grained, clay-like particles attempting to migrate through rock, sand, and other fine, clay-like sediments. These surrounding fine-grained materials would prevent the effective migration of any of the drilling mud, resulting in none of the chemical constituents reaching the benthic zone or seafloor, let alone open seawater. There would be no impact to water quality, especially turbidity, because these fine-grained materials are not expected to migrate.

None of the soluble additive constituents are expected to migrate either due to the lack of hydrostatic potential where the bore pipe and drilling mud are contained. If any of the soluble additive constituents were to migrate out of the drilling mud, which is not expected this mud would have to travel through approximately 50 to 70 feet of rock, sand, or clay to reach the benthic zone, mixing with pore water (i.e., water surrounding benthic sediments) throughout the 50 to 70 feet of the sediment column to reach the seafloor. After that distance of migration, it is expected that dilution of the drilling mud water with surrounding pore water would have diluted the chemical constituents to concentrations so low as to be likely non-detectable. Therefore, if any of the drilling mud water every reached seawater, no impacts to water quality are expected, and therefore no impacts to the natural resources at the site.

Additionally, over this period of migration, some or all of these soluble chemical constituents would be bound to other chemicals, metals, or organic material in the sediment before reaching the benthic zone or seafloor. This binding would further reduce the concentrations of chemical constituents below detection limits.

In summary, no migration of the drilling mud is expected to occur over time. However, if migration does occur, it is expected that concentrations of the drilling mud additives and their chemical constituents would be orders of magnitude below ecotoxicity threshold concentrations (and therefore non-hazardous to natural resources) and undetectable, given that the chemical constituents. The proprietary product are below ecotoxicity threshold concentrations at current concentrations in the bore hole (Section 3.1.1).

3.1.2.2 Other Remaining Materials

The Other Remaining Materials, including the steel bore pipe, the telemetry wire, the tungsten carbide drill head, the monel, the ParaTrack probe, the ParaTrack Gyro Module, and the jetting module are all solid metals or pieces that are built for stability and durability and are not expected to migrate to any degree within the foreseeable future.

In the case of the steel bore pipe with the TK™-34P internal plastic coating, the component is designed to remain in the environment and protect the subsea cable and therefore has long-term durability. According to the SDS for a steel bore pipe, the solid alloy is not expected to migrate into sediments (United States Steel Cooperation 2014). Additionally, the TK™-34P internal plastic coating is meant to further prevent corrosion (National Oilwell Varco 2020). Eventually, the steel will begin to react with oxygen and corrode. However, the rate of the corroding process is dependent on the amount of oxygen available in the surrounding environment (United States Steel Cooperation 2014). In the bore pipe's current location, buried under an average of 50 to 70 feet of sediment, with low oxygen levels, and encased in the surrounding hardened drilling, corrosion will occur at a very slow rate. If corrosion does occur, the pipe is still encased in the hardened drilling fluid, which will prevent migration to the seafloor or seawater.

The other remaining materials, including the tungsten carbide drill head, the monel, the ParaTrack probe, the gyro module, and the jetting module, are all solid metal pieces not expected to migrate in the future. If these components are broken down to their constituent parts, which will occur over an indeterminate period of time, they are still encased in the hardened drilling mud borehole, preventing migration to the seafloor or seawater, and therefore preventing impacts to water quality and natural resources.

3.2 Geologic Events

The Jupiter Landing Site in Tierra del Mar, Oregon, is located in a region referred to by geologists and other scientists as Cascadia Seduction Zone (Cascadia). Cascadia extends along the Pacific Northwest coast from southern British Columbia to Northern California. The geo-hazard characteristics of the region are related to and a function of the subduction zone (the oceanic plate is moving generally northeastward beneath the edge of the North American continental plate) that roughly parallels the coastline and is located at the base of the continental slope 10 to 20 miles offshore in the region. The primary geo-hazard for the Cascadia Seduction Zone is the potential for a large-scale earthquake, accompanied by consequent geo-hazards such as mass-movements or landslides, liquefaction, and tsunamis.

The consensus within the scientific community is that a large-scale earthquake (Magnitude 9 or M9) is relatively likely within the next 50 years; by one set of estimates, that likelihood is placed at a 37 percent chance of occurrence (Oregon Seismic Safety Policy Advisory Commission 2013). The coastal region of Oregon is expected to experience heavy to very heavy damage, with low-lying coastal areas such as Tierra del Mar experiencing very heavy damage to structures and surface construction features (towers, bridges, roadways, etc.) due to a combination of ground motion and the accompanying tsunamis.

The Department of Geology and Mineral Industry (DOGAMI) for the State of Oregon maintains a database and clearinghouse for geo-hazards addressed above (https://www.oregongeology.org/default.htm). Figure 1 included in Appendix F, (Earthquake Figure) is taken from the DOGAMI web site and illustrates the expected ground motion along the Cascadia as very-strong to severe along the coastal areas, and indicates that the nearest seismically active fault is offshore

and approximately 6 to 7 miles south of the Landing Site. There are no mapped seismically active faults intersecting the Remaining Material that would pose a risk for severing or displacing the drilling equipment.

Based on the location of the drilling mud, now entombed below the seafloor in the strata, it is highly unlikely for release even under the most severe seismic movements. This is evidenced by recent studies done in the Santa Barbara Channel, California, on the shell mounds (similar composition as hardened bentonite) remaining after decommissioning of the 4H platforms. Briefly, in 1995, four offshore platforms were removed in their entirety. Each platform location contains a large mound of consolidated marine sediments and shells over drill cuttings and muds on the seafloor. Each mound is approximately 35 feet high and approximately 250 to 350 feet in diameter. During the decommissioning, the California State Lands Commission required detailed seismic modeling of the mounds to address the stability under seismic activity (Chevron 2014). During this study, detailed bathymetry of the current state of the mounds and surrounding seafloor was used to model various seismic activity. Results of this study showed that seismic events as high as a magnitude 11.5 were not sufficient to cause movement or fracturing of the mounds. The HDD drilling mud entombed deep under the seafloor would require a much larger seismic event (off the Richter scale) to mobilize or expose the hardened mud.

Submarine landslides triggered by earthquake ground motion typically occur along the continental slope separating the continental shelf from the deeper ocean floor. The edge of the continental shelf along this portion of the Oregon coast is 6 to 10 miles offshore in water depths of approximately 600 feet. Recent studies of mass-movements along the continental slope above the subduction zone forming the western edge of Cascadia concluded that most of that mass-movement occurred in the lower portions of the continental slope, beyond the edge of the continental shelf (Hill et al. 2020). The Remaining Materials at this site extend approximately 1,700 feet offshore. Based on the gradual slope of the seafloor and the above-referenced research findings, the predicted locations for submarine mass-movements would be at least 6 to 10 miles west of the Remaining Materials.

Mass-movements or landslides on the mainland can result from earthquake ground motion in areas of steep slopes or slopes with inherent structural weaknesses. DOGAMI catalogs the risk for landslide activity as severe for the upland slopes to the east of Sandlake Road, east of Tierra del Mar (see Figure 2 in Appendix F, Landslide Risk). Although that landslide potential may pose a risk to the homes and surface structures of Tierra del Mar, should a landslide extend from those uplands across the highway, there is no reasonably foreseeable scenario under which a landslide would pose a risk or shift the location of the Remaining Materials, which are at an average depth of 50 feet and located offshore to the west of Tierra del Mar.

Liquefaction is a phenomenon where the earthquake vibrations in fine-grained, saturated soils cause the soils to behave like a viscous liquid rather than a solid. Liquefaction soils can flow over the ground. In addition, the liquefied soils lose bearing strength, expand in volume producing uplift/spreading, and once the vibrations cease, the affected area is then susceptible to subsidence. The loss of the soil strength can result in building and structures failures and affect buried infrastructure. Research on the behavior and performance of buried pipelines in areas affected by large earthquakes provides data to help predict the potential for earth movements to adversely affect the Remaining Materials (Saeedzadeh and Hataf 2011). The research focused on pipelines that are much greater in diameter than the Remaining Materials, evaluating pipelines that are approximately 3 to 10 feet in diameter and buried at depths of approximately 6 to 50 feet. The researchers concluded that the smaller diameter pipelines moved significantly less than the larger diameter pipelines, and that the pipelines buried at depths greater than approximately 35 to 40 feet exhibited no discernible movement. Based on this research, it is highly improbable that the approximately 5-inch-diameter drilling pipe buried at an average depth of 50 feet below the seafloor would be subjected to movement as a result of earthquake-induced liquefaction.

The adverse impact resulting from tsunamis is a function of the area of inundation and scour resulting from the arrival of the tsunami and resultant land drainage. The coastal area encompassing Tierra del Mar is expected to be inundated by tsunami conditions in the event of a Cascadia subduction earthquake (see Figure 3, Appendix F, Tsunamis). Assessment of the tsunami scour resulting from the 2004 Ardaman Sumatra earthquake (M9) included a comparison of FEMA methods for scour predictions to field observations (Francis 2008). The FEMA method applied to the site conditions and the tsunami predicted scour depths of 1 to approximately 15 feet, where field observations following the tsunami confirmed that scour was less than approximately 10 feet throughout the area of impact. Based on the deeper burial of the Remaining Materials at an average depth of 50 feet below the beach/seafloor, the results of the above-referenced research indicate that it would be unlikely for tsunami scour to expose the Remaining Materials.

Regarding coastal erosion, with climate change and the slow rise of the oceans, upland coastal erosion is expected to increase with the shoreline moving to the east. However, as coastal erosion occurs, the water where the Remaining Material is located gets deeper and the high water mark on land moves further to the east. Generally, the deeper the water, the less impact from waves on the seafloor bottom, lessening the chance of disturbance of the Remaining Materials.

4. IMPACT ANALYSIS OF ATTEMPTED RECOVERY

4.1 Recovery Options

ERM, in consultation with a reputable independent marine and drilling contractor, determined that additional drilling or dredging are the two options to consider in terms of feasibility and impacts for recovery of the Remaining Materials. The logistics of these options are described below along with an analysis of impacts.

4.1.1 No Action Alternative

The subject of this independent analysis is to analyze the No Action Alternative of leaving the Remaining Materials in place, the results of which are throughout the document and summarized in Section 5, Conclusions. It is important to note that under the No Action Alternative, the borehole behind the Remaining Materials is likely already collapsed due to its location within sand, and the entry pit at the Landing Site has been backfilled and capped with asphalt. Appendix B, Photo Log, contains photographs of the backfilled and patched entry pit.

4.1.2 Horizontal Drill Recovery

The option of extracting the Remaining Materials using HDD technology would require redrilling the collapsed March/April 2020 bore path by following the telemetry data acquired during the initial advancement of the pilot bore. This option is unproven at this distance, and would require locating a 6-inch pipe at approximately 520 feet offshore.

According to a third-party HDD contractor, the process for attempting to recover the Remaining Materials would be as follows:

- Using standard HDD drilling techniques, the drill head assembly is advanced to the end of the buried pipe, at which point, the milling tool grinds down the severed pipe to flatten the uneven pipe surface.
- Following milling, a tool is used to form a connection with the newly milled drill rod.
- With the overshot tool establishing a sealed connection at the end of the old drill rod, an attempt is made to rotate the entire drill string using the drill rig.
- Assuming the drill rig is able to rotate the drill stem, slow pull back of the Remaining Materials can begin until all the drilling material is fully retrieved from the borehole.

However, with this approach, there are several limiting technical factors to consider that render this option nearly impossible to achieve:

- The drilling operator must be able to re-drill the bore following the exact profile from the pilot bore telemetry data, which is generally horizontally inaccurate up to 2 feet, to align the fishing tooling with the end of the buried drill stem.
- The milling tool must effectively grind down the end of the buried drill stem to ensure a flush seal.
- The overshot tool must capture and seal the buried drill stem ensuring effective mud circulation and rotational pullback of the drill rods.
- If mud circulation is not re-established, further rotation could likely risk breaking the drill rod again as friction is very high from sediment resting on the buried drill string.
- The drill rig could “dead pull” the drill rod with no rotation or mud circulation; however, the drill rig would need to be rated for that amount of force and the risk of breaking the drill rod due to excessive frictional force is likely.

4.1.3 Dredge Recovery

The second identified recovery option for the Remaining Materials would be to dredge the entire length of the Remaining Materials. A brief description of what a dredging process may entail is as follows:

- A barge would be positioned over the bore pipe and a barge crane used to excavate the seafloor sediment down to the estimated 70 feet, moving from the shore end progressively away from the shore.
- In addition, the sides of the excavation channel would need to be sloped to prevent the sediment from collapsing back into the excavation channel, especially if divers are being used to help remove the Remaining Materials.
- Close to shore where there is extensive wave action and the sand has a high rate of suspension and movement, the slope of the dredge channel would need to be closer to 1 to 15. This means that to reach a depth of approximately 70 feet would require a channel that has sloped side extending 1,050 feet on either side of the channel.
- The sediment in these sloped sidewalls would not be removed, but would be disturbed. However, having slopes that extend to 1,050 feet on either side of the bore pipe would prevent a potentially dangerous collapse, especially if divers will be working in the channel.
- The excavated material from the dredge channel would be stored on multiple barge vessels during the excavation process, then placed back in the channel following removal of the Remaining Materials.
- Once the bore pipe is located, commercial divers would be necessary to inspect the bore pipe, assess the connection points for extraction, and potentially to cut the pipe at the connection points. These cut pieces of bore pipe could then be lifted out of the excavation channel by the barge crane.
- The last 90 feet of Remaining Materials would require marine rock boring equipment. The rock would need to be removed from around the Remaining Materials, placed on the barge vessels with the other excavated sediment, and then placed back in the channel once the Remaining Materials have been removed.
- Following the removal of the Remaining Materials, the excavated material would be used to backfill the excavated channel and return the seafloor to its original profile. It is estimated that this recovery option would take at least 2 months of 24-hour operations.

4.2 Recovery Impacts

4.2.1 Drilling Option

The first recovery option, utilizing HDD to recover the Remaining Materials, would result in an extended drilling timeframe with a near impossible outcome of recovery. The impacts associated with this option are identical to those assessed for permitting the Jupiter Project and conventional HDD activities undertaken, including temporary noise and visual disruptions.

While the associated impacts would be aligned with acceptable levels of disturbance, already permitted by local and state agencies, the limited feasibility of this option for recovery introduces a risk of extended temporary impacts with an extremely low likelihood of success. As concluded within this report, there are no identified environmental, scenic, recreational, or economic impacts to leaving the Remaining Materials in place; therefore, attempts to remove the Remaining Materials with an extended drilling operation is less favorable from an impact standpoint.

4.2.2 Dredge Option

This option would result in extensive impacts to offshore natural resources due to excavation of sediment, anchoring at the site, and other vessel-related impacts, including potential marine mammal disturbance and air emissions. There would be direct recreational and scenic impacts during the 2-month duration of the dredging operation. All impacts imposed would be significantly greater than the No Action alternative which requires no vessel use, sediment excavation or natural resource disturbance.

The dredging option described above is significantly less favorable from an environmental, recreational and scenic stand point than leaving the Remaining Materials in place due to the short-term and long term impacts associated with a dredging operation and sea floor recovery.

5. CONCLUSION

ERM's analysis concludes that there are currently no adverse environmental, scenic, recreational, or economic impacts resulting from the drill break and presence of Remaining Materials 50 to 70 feet below the sea floor, nor is there a reasonably conceived scenario (e.g., earthquake, tsunami, long-term coastal erosion) that would expose the Remaining Materials to the surrounding environment and result in future impacts. For this reason, the recommended environmentally-preferred alternative is to leave the Remaining Materials in place. The following summarizes the conclusions of this analysis:

- The drilling mud has presumably hardened and is effectively encasing the drilling materials trapping additive constituents and limiting movement or migration within the surrounding sediment and rock.
- The buried drilling components are solid metal pieces that will corrode in place over time at a very slow rate given the low levels of oxygen and seawater at such depths; this oxidation process will create a hardened shell around the metal, which is surrounded by mud; migration would be negligible.
- The lithology (e.g., sediment) surrounding the Remaining Materials provides an additional layer of migration prevention with a minimum 50 foot buffer between the Remaining Materials and the biologically-active benthic zone or seafloor. This depth of burial essentially eliminates any ecological or public risks associated with leaving the Remaining Materials entombed in the seafloor strata.
- There are no mapped seismically active faults intersecting the Remaining Material that would pose a risk for severing or displacing the drilling equipment. Based on the gradual slope of the seafloor, the predicted locations for submarine mass-movements would be at least 6 to 10 miles west of the Remaining Materials.
- Based on FEMA tsunami observations, scour depths near the Landing Site are estimated to be fewer than approximately 10 feet; therefore, not imposing a risk to uncovering the Remaining Materials in the event of a tsunami.

Regarding recovery options, the use of HDD to recover the Remaining Material is a nonviable option given the extremely low probability of success as the drill bit would need to perfectly align with the 6-inch bore pipe 520 feet from shore. The second option of dredging from the seafloor would result in extensive environmental impacts from sediment excavation, anchoring, and using vessels and barges over a 2-month period. The environmentally preferable option, and one with no perceived scenic, recreational, or economic impacts, is the "No Action" alternative to leave the Remaining Materials at a depth of 50-70 feet below the seafloor.

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APPENDIX A GEOSYNTEC PEER REVIEW ACKNOWLEDGEMENT

APPENDIX A

PEER REVIEW ACKNOWLEDGEMENT

Geosyntec Consultants Inc. provided and independent peer review of ERM's Independent Hazard Analysis for the Jupiter Drill Break dated August 28, 2020. Based on the experience and technical backgrounds of its reviewers, it is Geosyntec's professional opinion that the conclusions of the analysis presented relative to the sections reviewed are sound and supported by relevant science.

The peer review was conducted by:

1) **Tony Rice, P.E.**; Tony is a senior geotechnical engineer and a subject matter expert in Horizontal Directional Drilling (HDD) with more than 35 years of consulting experience. He has worked on HDD drilling projects in the Oil & Gas pipeline industry and Telecommunications sector since 1988. His expertise includes HDD feasibility evaluations, HDD designs, troubleshooting HDD projects for owners and contractors, and conducting forensic evaluations for problematic HDD projects. He has worked on HDD projects throughout North America, South America and Asia.

2) **Lance Fontenot, Ph.D.**, **PWS**; Lance is an Environmental Toxicologist with over 25 years of experience specializing in assessing the human health and ecological effects of hazardous substance releases. His experience includes ecological risk assessments, wetland assessments, biological assessments, and impact assessment of aquatic species and habitats.

3) **Sean Ragain, R.G.**; Sean is an Oregon Registered Geologist with more than 30 years of professional consulting. Sean's diverse experience includes conducting environmental investigations onshore and offshore in the USA and internationally.

Geosyntec Consultants, Inc.

Sean K. Ragain
Senior Principal

Geosyntec consultants

engineers | scientists | innovators

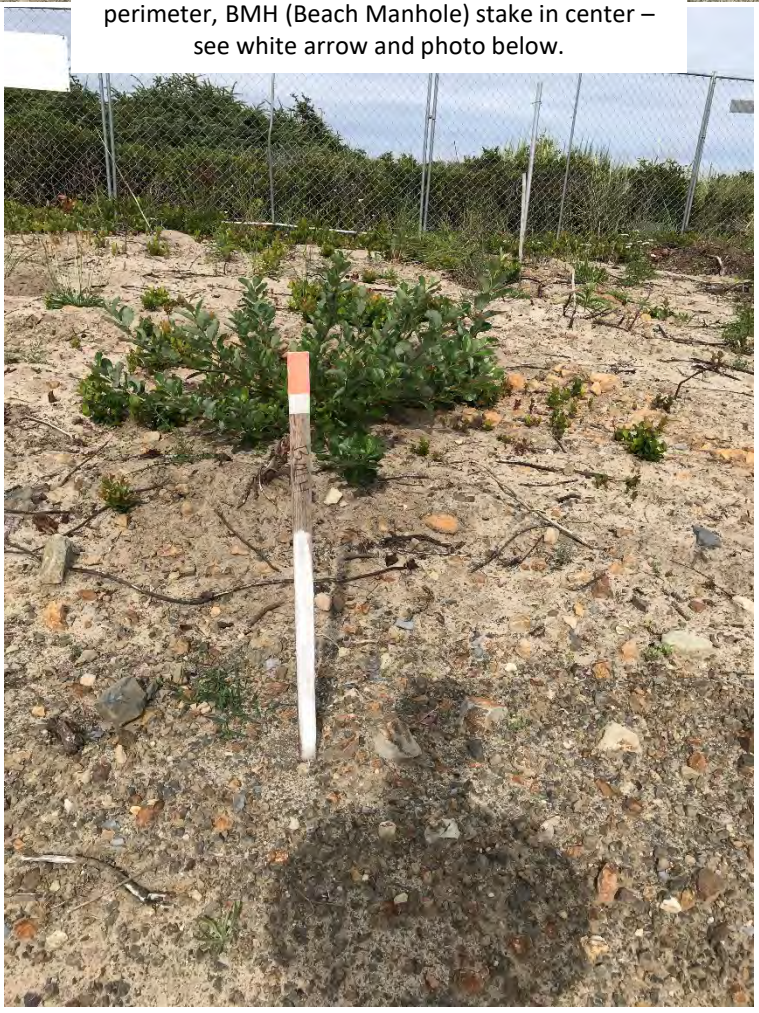
APPENDIX B SITE VISIT PHOTO LOG

Jupiter Landing Site Photo Log

Facing west overlooking beach above HDD borepath.

Facing northwest towards Pacific Ocean from west extent of landing zone perimeter; viewing north of HDD borepath (not visible).

180-degree panoramic facing west along borepath alignment from east extent of landing zone perimeter, BMH (Beach Manhole) stake in center – see white arrow and photo below.



Facing northeast from BMH towards houses to the north of landing zone perimeter and west of Sandlake Road. Tall fences for sound dampening fabric.

Facing north along Sandlake Road from outside east extent of landing zone perimeter fence.

Facing due from west shoulder of Sandlake Road, fiber optic lines to be tied-in visible on east shoulder of Sandlake Road.

APPENDIX C MUD REPORT 28 APRIL 2020

Carson Corporation			Mud Report					
Date:	04-28-2020		Project Name:	Maritech		Recycler Operator:	John Hutton	
Job Number:	6277		Location:	Pacific City, OR		Recycler Asset #:	16122	
Time	**Viscosity**	**PH**	**Sand Content**	**Clean Weight**	**Dirty Weight**	**Additive Consumption Since Last Check**	**Bentonite Consumption Since Last Check**	**Notes/Comments**
9:00 AM	80	8	0.25%	8.7		Sand Force (1 LB) Soda Ash (1 LB)	48	
11:00 AM	76	8	0.25%	8.7		Wyo-Vis (2LB) Platinum DD(soap)	49	
1:00 PM	75	8	0.25%	8.7		Sand Force (2 LB) soda ash (2LB)	50	
3:00 PM	77	8	0.25%	8.7		Platinum DD (Soap) Sand Force (1 LB) Wyo-Vis (2 LB) Soda Ash (1 LB)	48	
						Platinum DD (Soap) (Total daily consumption = Approximately 0.5 gallons)	Total 195 Bags	
						wyo-vis (Total daily consumption = 4 lbs)		1/2 FRAC TANK OF WATER
						Sand Force (Total daily consumption = 4 lbs) Soda Ash (Total daily consumption = 4 lbs)		
Units	Seconds / Quart	Scale	%	Pounds / Gallon		**Bentonite & Additive Inventory on Hand**		
						Description		**Pallets**
Water						Tru-Bore		3 1/4
Mud Parameters								

NOTE: Please take these measurements at the start of daily operations and repeat every hour throughout the day and at the completion of shift

APPENDIX D SAFETY DATA SHEETS

Material Safety Data Sheet

Reference – MSDS
Date – March 2011

1. PRODUCT IDENTIFICATION & COMPANY INFORMATION

Product name: Various grades of welding and metal spraying consumable carrying the trademarks
DURANICKEL, INCOLOY, INCONEL, INCO-CORED, INCO-WELD, MONEL, Nickel, NILO, NIMONIC, NI-ROD, INCOFLUX
Full list given in tables 2.1-.2.4

Other/generic names: Filler Metal, Flux, Flux Cored, Welding Electrode, Weldstrip, & Thermal Spray (TSW)

Product use: Welding & metal spraying consumables, See applicable product technical data sheets on website for information of typical scope of use and application, not all products are suitable for all processes or applications.

Filler Metal	*Used for joining and overlaying, using GTAW, GMAW, Plasma and SAW (with suitable flux) welding processes*
Flux Cored	*Used for joining and overlaying, using GMAW welding processes*
Welding Electrode	*Used for joining and overlaying, using SMAW welding process*
Weldstrip	*Used for overlaying, (with suitable flux) for submerged arc or electroslag welding process*
INCOFLUX	*Flux used for joining or overlaying with appropriate filler metal or weldstrip for submerged arc or electroslag welding process*
Thermal Spray(TSW)	*Used to apply nickel alloy coating by a variety of thermal spray process*

Manufacturer:

Special Metals Welding Products Company

1401 Burris Road, Newton,
North Carolina 28658
United States

For more information
Tel +1 828-465-0352
Fax +1 828-464-8993
Email info@smwpc.com

c/o Special Metals Wiggin Ltd
Wiggin Works, Holmer Road,
Hereford, UK, HR4-9SL

Tel +44 (0)1432 382200
Fax +44 (0)1432 264030
Email sales.uk@smwpc.com

Australian Distributor - Alloys International Pty Ltd - 25 Raymond Road, Laverton North Vic 3026 Phone (03) 8368 2222

Emergency telephone **+1 828-465-0352** **+44 (0)1432 382200**

2. COMPOSITION/INFORMATION ON INGREDIENTS

Information on ingredients is given in Table 1 and the compositions of individual products in the alloy families or categories listed above are given in the product composition tables 2.1-2.4. Please refer to the appropriate alloy name or designation.

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW: Silver to gray metal wire or strip. (Welding Electrodes are flux coated, Flux Cored has a flux center; flux is granular powder). Not normally considered hazardous as shipped. Ends and edges can be sharp and gloves should be worn when handling.

POTENTIAL HEALTH HAZARDS

Skin: Although not normally hazardous, some individuals can develop allergic skin reactions to nickel and other metallic ingredients. Ends of wire and edges of strips may be sharp and can cause cuts.
During welding and spraying - Fumes generated may be irritating to the skin. UV radiation produced can cause burns (ray burn). Hot metal can cause burns.

Eyes: As shipped, product does not pose a hazard to the eyes however ends of wire and edges of strip are sharp and can cause cuts.
During welding and spraying - Fumes generated can be irritating to the eye. Ends of wire may be sharp and can cause cuts or hot and cause burns. UV radiation produced can cause burns (arc eye).

Inhalation: Fumes generated by welding and spraying processes can be irritating and toxic.

Ingestion: Not a likely route of entry. Metal ingestion can cause toxic effects.

Delayed effects: Inhalation of welding or spraying fumes may cause damage to the lungs and respiratory tract including but not limited to fibrosis of the lung which can reduce lung capacity and produce difficulty breathing. Cobalt and Nickel are animal carcinogens and inhalation of fumes and dusts should be avoided. Prolonged inhalation of Manganese fumes and dusts may cause irreversible damage to the nervous system resulting in Parkinson's Disease-like symptoms (tremors, weakness, paralysis, etc.)

	Nickel	Cobalt
EC Label No	231-111-4	231-158-0
Index No	028-002-00-7	028-001-00-9
Designation:	Xn Harmful	Xn Harmful
Risk Phrases:	R40 Possible risk of irreversible effects R43 May cause sensitization by skin contact	R42/43 May cause sensitization by inhalation and skin contact R53 May cause long-term adverse effects in aquatic environments

4. FIRST AID MEASURES

Skin: Wash skin with soap and water to remove any metallic particles. If a rash or burn develops, seek medical attention.

Eyes: Flush particles from eyes with clean water for at least 15 minutes. If irritation persists or burn develops, seek medical attention.

Inhalation: Remove from exposure. If respiratory irritation persists, seek medical attention.

Ingestion: If metallic particles are swallowed, seek medical assistance.

Advice to physician: Treat symptomatically.

5. FIRE FIGHTING MEASURES

FLAMMABLE PROPERTIES

Flash Point & Method	Solid material – No flash point
Autoignition Temperature:	Not flammable
Flame Propagation Rate (solids):	Not flammable
OSHA Flammability Class:	None – solid material

Extinguishing Media:	Use agent appropriate for surrounding fire.
Unusual Fire And Explosion Hazards:	None
Special Fire Fighting Precautions/Instructions:	Wear self-contained breathing apparatus. Hazardous metallic fumes can be generated in a fire.

Nonflammable except for packaging, however sparks from welding or grinding in user operations could ignite flammable or combustible liquids, vapors and solids.

6. ACCIDENTAL RELEASE MEASURES

IN CASE OF SPILL OR OTHER RELEASE: Wear proper protective clothing. Pick up spilled articles and place into container.

7. HANDLING AND STORAGE

Normal Handling: Under normal circumstances the materials do not produce any hazardous products and as such do not require any special precautions. However, see Section 10 "STABILITY AND REACTIVITY". The transient handling of the materials would not be expected to produce any sensitization but it is good practice to use gloves for handling. The normal precautions for handling heavy objects with possible sharp edges should also be observed.

Personal hygiene - Apply good standards, wash hands after use and before eating.

Storage Recommendations: Store in a dry place and protect from contamination with other materials.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

ENGINEERING CONTROLS: Provide general ventilation and local exhaust ventilation when welding, spraying, cutting or grinding to maintain concentrations of metal dusts and/or fumes below allowable exposure values.
Maintain exposures below the published exposure levels. Use industrial hygiene air monitoring to ensure that your use of this material does not create exposures that exceed the recommended exposure limits. Refer to the following sources for important additional information:

In U.S.A.: 29 CFR 1910, ANSI Z49.1, American Welding Society, OSHA, U.S. Dept of Labor
In Canada: Canadian Standards Association, CAN/CSA - W17.2-M87
In UK: Current exposure limits under Health & Safety Executive EH40 are given in table 2.

PERSONAL PROTECTIVE EQUIPMENT

Skin Protection: Wear gloves, face protection and flame retardant clothing, do not expose skin to the heat, radiation and spatter from welding or spraying operations.

Eye Protection: Eye protection, to the appropriate national standard, is recommended when welding, cutting, spraying or grinding. Do not expose eyes to the heat and radiation from welding operations, use appropriate grade optical filters (welding glass) for welding or spraying process operations.

Respiratory Protection: Respiratory protection is necessary when exposure limits for airborne contaminants are exceeded during welding, grinding or cutting operations. Use air-supplied respirator in confined spaces.

In the USA, use only NIOSH-approved respirators in accordance with 29 CFR 1910.134, or other nationally approved respirators.

In the EU, if required use protection to EN136 (full face respirators), EN140 (half mask respirators), EN149 (filtered half masks (disposable)) or other appropriate EN standard. In the rest of the world use respiratory protection to the appropriate national standard.

Additional Recommendations: Source of running water to wash skin and eyes

Wear ear protection to the appropriate national standards where high levels of noise are experienced.

Exposure Guidelines See Appendix 1

9. PHYSICAL AND CHEMICAL PROPERTIES

	Filler Metal, Weld Strip and Thermal Spray Wire	Welding Electrode	Flux Cored Wire	Flux
Appearance:	Grey to silver or bronze metal	Varies grey, black, brown coating with metallic silver inner	Metallic silver outer with flux core	Varies grey, brown, green particles
Physical State:	Solid	Solid	Solid	Solid (Powder)
Molecular Weight:	Mixture	Mixture	Mixture	Mixture
Chemical Formula:	Mixture	Mixture	Mixture	Mixture
Odor:	Odorless	Odorless	Odorless	Odorless
Specific Gravity (water = 1.0):	8 – 9	4-7	5 - 8	
Bulk Density				0.8 – 1.1
Solubility In Water (wt. %):	Insoluble	Insoluble	Insoluble	Insoluble
Melting Point:	> 2300F (1260 ºC)	> 1800F (>1000^{o}C)	> 1800F (>1000^{o}C)	> 1800F (>1000^{o}C)
Flash Point	None	None	None	None

Other physical and chemical properties, e.g. as described in 91/155/EEC and in the Approved Code of Practice, ref. 11, have no safety implications in relation to these materials.

10. STABILITY AND REACTIVITY

These consumables are stable and no hazardous decomposition products are formed upon exposure to water or the atmosphere. Nickel can react with carbon monoxide in reducing atmospheres to form nickel carbonyl, an extremely toxic gas.

11. TOXICOLOGICAL INFORMATION

Nickel and cobalt are classified as Category 3 carcinogens. The exposure route of concern is inhalation.

As shipped, these complex alloys in massive form have no known toxicological properties other than causing allergic reactions in individuals sensitive to the metal(s) contained in the alloys. However, dust from flux or user-generated dusts and fumes may on contact with the skin or eyes produce mechanical irritation. Chronic exposures coupled with sweat could cause dermatitis (skin) or conjunctivitis (eyes).

Excessive inhalation of dust or user-generated fumes from welding or metal spraying may, depending on the specific features of the process used, pose a long-term health hazard. The International Agency for Research on Cancer (IARC) has concluded that welding fumes are possibly carcinogenic to humans.

The ingredients of fumes and gases generated in welding, metals spraying and grinding will depend on the base metal and the details of the specific process being used. Ingredients may include metals, metal oxides, chromates, fluorides, carbon monoxide, ozone, and oxides of nitrogen. Phosgene can be produced if chlorinated solvent vapors are present in user operations.

More detailed toxicological information is given in APPENDIX 1

Composition of typical welding fume given in table 3.1 – 3.7,

Contamination or surface preparations etc can affect the composition of the produced fume.

Metals Spraying - Many variations of process are available; refer to table 2.1 in association with guidance from equipment manufacturers for likely constituents of produced fume.

DELAYED (SUBCHRONIC AND CHRONIC) EFFECTS:

Chromium	The International Agency for Research on Cancer (IARC) considers hexavalent chromium to be a carcinogen (lung, nasal) but does not have adequate evidence for chromium metal and trivalent chromium. Fumes have been associated with lung fibrosis.
Iron	Prolonged inhalation of iron oxide fumes can lead to siderosis, which presents as a benign pneumoconiosis.
Molybdenum	Repeated inhalation of fumes has caused kidney damage, respiratory irritation and liver damage in animals.
Nickel	Nickel metal is “reasonably anticipated to be a human carcinogen” (National Toxicology Program’s 10th Report). IARC states that nickel metal is possibly carcinogenic to humans. Epidemiological studies of workers exposed to nickel powders, dusts and fumes in the nickel alloy and stainless steel producing industries do not indicate a significant respiratory cancer hazard. Inhalation of nickel powder produced malignant tumors in rodent studies. Single intratracheal installations of nickel powder at levels close to the LD_{50} have caused malignancies in hamsters. Can cause skin sensitization in susceptible individuals through prolonged contact with skin.
Niobium	No data available.

12. ECOLOGICAL INFORMATION

As a solid metal object, Filler Metal products are not considered toxic to aquatic species.
Flux (being of mineral constituents) from flux coated electrodes, flux cored wire and flux may degrade over time.
Observe national and local standards for fume extraction systems

13. DISPOSAL CONSIDERATIONS

Unused consumable wastes are normally collected to recover metal values.
Dispose of fume, flux, slag, weld grinding residues, over-spray etc, from the work area, or from filters, in accordance with national, federal, state or local regulations. Refer to this MSDS, Table 3.1-3.7, for possible contents of collected fumes and other materials. These may be in the form of dust requiring special health precautions. Nickel is regulated in many countries as hazardous to the environment. Other metals may be regulated in specific jurisdictions. In UK most alloyed material would be regarded as special waste. Observe all National, State, and local environmental regulations.

Packaging - Dispose of by recycling

14. TRANSPORT INFORMATION

No special precautions are necessary for the transport of these materials.

15. REGULATORY INFORMATION

Classification and labelling requirements
Alloys containing less than 1% of nickel or cobalt are not classified as "dangerous for supply". Alloys containing more than 1% of either metal are classified as the metals themselves (see Section 3). However, in recognition of their essentially non-hazardous nature, these alloys in the massive form are not required to be labelled as hazardous.

Product Labeling - UK Manufacture

WARNING: PROTECT YOURSELF AND OTHERS. READ AND UNDERSTAND THIS LABEL. TAKE PRECAUTIONS WHEN WELDING. ASK FOR YOUR EMPLOYER'S SAFETY PRACTICES WHICH SHOULD BE BASED ON MANUFACTURER'S HAZARD DATA

Fumes and gases can be dangerous to your health. Arc rays can injure eyes and burn skin. Electric shock can kill. Read and understand the manufacturer's instructions and your employer's safety practices. Keep your head out of the fumes. Use enough ventilation or exhaust at the arc to keep fumes and gases from your breathing zone, and the general area. Wear correct eye, ear and body protection. Do not touch live electrical parts.

DO NOT REMOVE THIS LABEL

Product Labeling – USA Manufacture

PROTECT YOURSELF AND OTHERS – READ AND UNDERSTAND THIS LABEL – TAKE PRECAUTIONS WHEN WELDING – ASK FOR YOUR EMPLOYER'S SAFETY PRACTICES WHICH SHOULD BE BASED ON MANUFACTURERS HAZARD DATA AVAILABLE TO HIM

Fumes and gas as can be dangerous to your health. Arc rays can injure eyes and burn skin. Electric shock can kill. Read and understand the manufacturer's instructions and your employers' safety practices. Keep your head out of the fume. Use enough ventilation, exhaust at the arc or both, to keep fumes and gases from your breathing zone, and the general area. Wear correct eye ear and body protection. Do not touch live electrical parts. See WMA publication 236 hazards from welding fume available from the manufacturer.

DO NOT REMOVE THIS LABEL

- -

WARNING POSSIBLE CANCER HAZARD OR LUNG DAMAGE IF INHALED – MAY CAUSE ALLERGIC REACTION – MAY CONTAIN FLUORIDES

PROTECT YOURSELF AND OTHERS – before use, read and understand this label, the manufacturer's instructions, Material Safety Data Sheets [MSDS's], and your employer's safety practices, which should be based on the manufacturer's hazard data available to him. See American National Standard Z49.1, Safety in Welding and Cutting and OSHA Safety and Health Standards 29CFR1910.

FUMES AND GAS can be dangerous to your health. Skin sensitization, irritation of skin, eye and respiratory tract, neurological damage, or death can result from over exposure. Keep your head out of the fumes. Use ventilation, preferably local exhaust ventilation, adequate to keep the concentration of the fumes and gases below the exposure limits. Special attention to ventilation is required in confined, small or crowded spaces. If adequate ventilation is not available, wear appropriate respiratory protection. Wash skin after contact with dust or fumes.

Arc rays can injure eyes and burn skin. Electric shock can kill. Do not touch live electrical parts. Wear correct eye, ear and body protection

DO NOT REMOVE THIS LABEL

SARA SECTION 313 SUPPLIER NOTIFICATION:
Individual consumables covered by this MSDS may contain the following toxic chemicals subject to the reporting requirements of Section 313 of the Emergency Planning and Community Right-To-Know Act of 1986 and of 40 CFR 372: Chromium, Copper, Manganese, and Nickel. Refer to "Section 2" of this MSDS for the filler metal name and the percent by weight, and "Table 1" for the CAS Number for each chemical.

16. OTHER INFORMATION

Current Issue Date:	March, 2011
Previous Issue Date:	None
Changes to MSDS From Previous Issue Are Due To:	Change of format which includes additional information

MSDS prepared by Special Metals technical department in compliance with directive 91/115/EEC, 93/112/EEC and HSE (UK) Welding Information Sheet No.1 and is provided in good faith based upon the experience and knowledge of the company. It should not be taken as a guarantee of alloy properties for ordering these materials. Users should make their own assessment of workplace risks as required by other health and safety legislation

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1. U.S. National Toxicology Program - 10th Report on Carcinogens
2. Health and Safety Executive UK - EH40 - Occupational exposure limits; EH42 - Monitoring Strategies for toxic substances; EH44 - Dust the Workplace - general principles of protection; EH54 - Assessment of Exposure to Fume from Welding and Allied Processes; EH55 - The Control of Exposure to Fume from Welding, Brazing and Similar Processes; EH60 - Nickel and its inorganic compounds.
3. EH Health and Safety Executive's publications (www.hse.gov.uk)
4. HSC. Information approved for the classification, packaging and labeling of dangerous substances for supply and conveyance by road.

5. European Commission Directive 5/3/91 - 91/155/EEC.
6. European Commission Directive 10/12/93 - 93/112/EEC.
7. Twelfth adaptation of Council Directive 67/548/EEC - 91/325/EEC.
8. Sixth amendment of Council Directive 67/548/EEC - 79/831/EEC.
9. The Chemicals (Hazard Information and Packaging for Supply) Regulations 2002 No. 1689.
10. International Agency for Research on Cancer. Monographs on the evaluation of carcinogenic risks to humans. Vol 49 Chromium Nickel and Welding, 1990.
11. Approved Code of Practice. ISBN 0 7176 0859X.
12. European Norm - EN 1811.

Table 2.1
Nominal Composition (Weight %) Of
Filler Metal, Thermal Spray Wires and Weldstrips Covered By This MSDS

Trade Name	Al	Cr	Co	Cu	Fe	Mn	Mo	Ni	Nb	Si	Ti	W
DURANICKEL® 301 & 301TSW™	4	-	-	-	-	-	-	94	-	1	1	-
INCOLOY® 65	-	21	-	2	30	1	3	42	-	-	1	-
INCONEL® 52	<1	29	-	-	9	1	-	59	-	-	-	-
INCONEL® 52M™	1	30			9	1		57	1		1	
INCONEL® 53MD™	3	29	-	-	3	1	-	64	-	-	-	-
INCONEL® 601	1	23	-	1	14	1	-	61	-	-	-	-
INCONEL® 617	1	22	12		2	1	9	52		1		
INCONEL® 62 & 62T	-	16	-	-	8	1	-	74	3	-	-	-
INCONEL® 622	-	20	-	-	5	-	14	58	-	-	-	3
INCONEL® 625, 625T & 625TSW™	-	22	-	-	1	-	9	61	4	-	-	-
INCONEL® 718 & 718TSW™	-	19	-	-	19	-	3	53	5	-	1	-
INCONEL® 72 & 72TSW™	-	44	-	-		-	-	55	-	-	1	-
INCONEL® 8020 TSW	-	20	-	-	-	-	-	78	-	1	-	-
INCONEL® 8020M TSW	-	20	-	-	-	-	-	78	-	2	-	-
INCONEL® 82 & 82T	-	20	-	-	1	3	-	72	3	-	-	-
INCONEL® 92	-	16	-	-	7	2	-	71	1	-	3	-
INCO-WELD® 686CPT®	-	21	-	-	1	-	16	58	-	-	-	4
INCO-WELD® 725NDUR®	-	21	-	-	9	-	9	57	3	-	1	-
INCO-WELD® C-276 & C276TSW™	-	16	2	-	6	-	16	57	-	-	-	3
INCO-WELD® HX	-	22	2	-	19	-	9	47	-	-	-	1
MONEL® 400 TSW	-	-	-	32	1	1	-	67	-	-	-	-
MONEL® 60, 60N & 60TSW™	-	-	-	27	-	4	-	65	1	1	2	-
MONEL® 67 & 67N	-	-	-	68	1	1	-	31	-	1	-	-
NC 80/20	-	20	-	-	-	1	-	79	-	-	-	-
Nickel 200 TSW	-	-	-	-	-	-	-	99	-	-	-	-
Nickel 61 & 61N	-	-	-	-	-	-	-	96	-	-	3	-
NILO® 365					52			43	3		1	
NILO® CF36™	-	-	-	-	61	-	-	36	2	-	-	-
NILO® CF42™	-	-	-	-	56	-	-	42	2	-	-	-
NIMONIC® 263	1	20	20	-	-	-	6	51	-	-	2	-
NIMONIC® 86	-	25	-	-	-	-	10	65	-	-	-	-
NIMONIC® 90	2	20	17		-	-	-	60	-	-	3	-
NIMONIC® PE11	1	18	-	-	34	-	5	39	-	-	2	-
NIMONIC® PE16	1	17	-	-	34	-	3	44	-	-	1	-
NIMONIC® PK33	2	18	14	-	1	-	7	56	-	-	2	-
NI-ROD® 44	-	-	-	-	48	10	-	42	-	-	-	-
NI-ROD® 44HT™	-	7	-	-	37	11	-	43	1	-	-	-
NI-ROD® 55	-	-	-	-	44	-	-	55	-	-	-	-
NI-ROD® 99	-	-	-	-	-	-	-	99	-	-	-	-
UDIMET® L605		20	55					10				15
WASPALOY	1	19	13		2	1	4	59			3	

Table 2.2
Composition (Weight %)
Of Flux Coated Electrodes Covered By This MSDS

PRODUCT NAME	Al	Al_2O_3	$BaCO_3$	BaF_2	C	$CaCO_3$	CaF_2	Cr	Co	Cu	Fe	Fe_2O_3	K_2O	K_2SiO_3	Li_2Co_3	Mn	MnO	Mo	Nb	Ni	SiO_2	$NaAlF_6$	Na_2SiO_3	$SrCO_3$	Ti	TiO_2	W
INCOLOY® 135						5-10		15-40		1-5	15-40					1-5		1-5		30-60	0.1-1	5-10	1-5		1-5	1-5	
INCONEL® 112 & 112T						5-10		15-40			1-5							5-10	1-5	40-70	1-5	5-10	1-5			1-5	
INCONEL® 112AC						5-10		15-40			1-5		1-3	1-5				5-10	1-5	40-70	1-5	5-10	1-5			1-5	
INCONEL® 117						5-10		15-40	5-10		1-5					0.5-2		5-10		40-70	0-5-2	5-10	1-5			1-5	
INCONEL® 122						5-10	1-5	15-40			1-5							10-30		40-70	0.1-1	5-10	1-5			1-5	1-5
INCONEL® 152						1-5		10-30			5-10					1-5			1-5	40-70	0.1-1	5-10	1-5	1-5		1-5	
INCONEL® 182 & 182T						5-10		10-30			5-10					1-5	1-5		1-5	40-70	0.1-1	1-10	1-5		1-5	1-5	
INCO-WELD® 686CPT®		1-5				3-7		10-30										10-30		30-60			1-5			3-7	1-5
INCO-WELD® A						5-10		10-30			6-12					1-5		1-5	1-5	30-60	0.1-2	5-10	1-5			3-7	
INCO-WELD® B						5-10	3-7	10-30			7-13					1-5		1-5	1-5	30-60	0.1-2		1-5				
INCO-WELD® C		1-5				1-5		10-30			30-60		1-5			1-5				5-10	1-5	1-5	1-5			5-10	
INCO-WELD® C-276						1-5		10-30	1-5		3-7					1-5		10-30		30-60	0.1-1	5-10	1-5			5-10	1-5
INCO-WELD® G3								15-25	1-3		15-21							4-8		45-55	3-6	1-10	1-5				0-2
MONEL® 187 & 187N						5-10	1-5			40-70					0.7-0.9	1-5				15.40	1.5	5-10	1-5		1-5	1-5	
MONEL® 190 & 190N			1-5			1-5	1-5			15-40						1-5				40-70	1-5	5-10	1-5		1-5	1-5	
Nickel 141 & 141N		1-5				5-10														40-70	0.5-2	5-10	1-5		1-5		
NI-ROD®	1-5		0-1		1-5	1-5	1-5				1-5	1-5								60-100			1-5	7-13			
NI-ROD® 44			1-5	1-5	1-5	1-5				1-5	30-60					7-13				30-60				7-13			
NI-ROD® 55					1-5	1-5	1-5				30-60	1-5								30-60				7-13			
NI-ROD® 55X			1-5	1-5	1-5	1-5				1-5	30-60					1-5				30-60				5-10			
NI-ROD® 60			1-5	1-5	1-5	1-5					30-60									30-60				7-13			
NI-ROD® 99X			1-5	1-5	1-5	1-5				1-5	1-5					1-5				60-100							

Table 2.3
Composition Of Flux-Cored Welding Wires Covered By This MSDS

Weight %	Ca0	CaF_2	C	Cr	Fe	Mn	MnO	Mo	$NaAlF_6$	Na_2O	Nb	Ni	SiO_2	TiO_2	K_2ZrF_6	ZrO_2
INCO-CORED© 625 AP	1-5			15-20			1-5	5-10		1-5	1-5	50-60	0.1-0.5	5-10		
INCO-CORED© 625 DH	1-5			15-20			1-5	5-10		1-5	1-5	50-60	0.1-0.5	5-10		
INCO-CORED© 82 AP				15-20	1-5	1-5					1-5	57-63	0.1-0.5	5-10		
INCO-CORED© 82 DH				15-20	1-5	1-5	1-5			1-5	1-5	57-63	0.1-0.5	5-10	1-5	1-5
NI-ROD© FC55		7-13	1-5		30-60	1-5			1-5			30-60				

Table 2.4
Composition of Flux Covered By This MSDS

Product Name	Al_2O_3	CaF_2	CaO	Cr_2O_3	MgO	Mn	MnO	Nb	Ni	K_2SiO_3	K_2O	SiO_2	$NaAlF_6$	TiO_2	ZrO_2	K_2ZrF_6	NaF	Others	
INCOFLUX® 4		60-100			1-5			1-5	1-5	1-5			3-7		1-5				
INCOFLUX® 5		60-100					10-30			1-5		1-5	3-7						
INCOFLUX® 6	15-40	40-70			3-7				1-5	1-5			3-7	3-7					
INCOFLUX® 7	15-40	40-70				1-5				1-5			3-7		5-20			Fe_3O_4	1-5
INCOFLUX® 8		60-100					10-30			1-5		1-5	3-7					Fe_3O_4	1-5
INCOFLUX® 9	1-5	15-20	28-33		2-6							28-33			4-8				
INCOFLUX® 10			85-95															$CaTiO_3$	1-5
																		NiMg	1-5
INCOFLUX® ESS1	10-15	65-80	10-15	3-8	3-7	1-5		1-5	1-5		1-3	1-5				3-7		Cr	1-5
INCOFLUX® ESS2	5-10	65-80		3-8	3-7	2-7		1-5	1-5	1-5	1-5	2-7	2-7			1-6	1-6	Cr	1-5
INCOFLUX® ESS3	20-40	45-70										5-15							
INCOFLUX® ESS4	5-10	65-80		5-10	3-7	2-7		1-5	1-5		1-5	2-7					1-6	Cr	1-5
INCOFLUX® NT100	15-40	40-70			3-7				1-5	1-5			3-7	3-7					
INCOFLUX® NT110	30-70	10-40					0-20			5-20		0-10		0-10				Cu	0-5
																		Na_20	0-5
																		$Na_2Si_4O_9$	5-20
INCOFLUX® NT120	26-33	30-35				0-5	2-4	1-5	1-5			2-4		4-7	8-13		1-6	$CaSiO_3$	1-5
																		Cr	0-5
																		Fe	1-6
																		Mo	1-6
																		Na_2O	2-4
																		$Na_2Si_4O_9$	1-6
INCOFLUX® SAS1	30-70	10-40	0-10			0-5	0-5			5-20		0-10		0-10				$CaCO_3$	0-10
																		Na_2O	0-5
																		$Na_2Si_4O_9$	5-20
INCOFLUX® SAS2	35-45	35-45		2-8		5-10				1-5								$CaSiO_3$	5-15
																		Cr	2-6
																		$CaTiO_3$	5-15

Table 2.5 - Nominal Composition (Weight %) Of Stainless Steel Filler Metal Covered By This MSDS

Trade Name	Fe	Cr	Ni	Mo	Mn	Si
INCO-WELD© 308, 308H, 308L, 308LSi	61-68	19-22	9-11	<0.5	1-2.5	<1
INCO-WELD© 309, 309H, 309L, 309LSi	54-61	23-25	12-14	<0.8	1-2.5	<1
INCO-WELD© 309LMo	52-59	23-25	12-14	2-3	1-2.5	0.6-1
INCO-WELD© 310	43-51	25-28	20-23	<.8	1-2.5	.3-.7
INCO-WELD© 312	51-59	29-32	8-10.5	<0.8	1-2.5	.3-.7
INCO-WELD© 316, 316L	57-65	18-20	11-14	2-3	1-2.5	.3-.7
INCO-WELD© 316LSi	57-65	18-20	11-14	2-3	1-2.5	.6-1
INCO-WELD© 347	61-68	19-21.5	9-11	<.8	1-2.5	.3-.7

Table 2.6 - Nominal Composition (Weight %) Of Aluminum Filler Metal Covered By This MSDS

Trade Name	Al	Si	Mn	Mg
INCO-WELD© 1050	>99.8			
INCO-WELD© 1080	>99.5			
INCO-WELD© 4043	Bal	4.5-6		
INCO-WELD© 4047	Bal	11-13		
INCO-WELD© 5154	Bal			3-4
INCO-WELD© 5183	Bal			4.3-5.2
INCO-WELD© 5356	Bal			4.5-5.5
INCO-WELD© 5556	Bal			4.7-5.5

Trace impurities and minor addition material names not listed above may also appear.

Table 2.7 - Nominal Composition (Weight %) Of Copper Filler Metal Covered By This MSDS

Trade Name	Cu	Sn	Mn	Fe	Si	Ni	Al
INCO-WELD© AlBZ8							
INCO-WELD© CuSN-A	Bal	4-6					
INCO-WELD© C11	Bal	5.5-8					
INCO-WELD© Cu	>98	<1	<0.5		<0.5		
INCO-WELD© CuSi-A	Bal	<1	<1.5	<.5	2.8-4		
INCO-WELD© CuAl-A2	Bal			<1.5			8.5-11
INCO-WELD© CuAL8-NI2							

Table 3.1
Composition of Welding Fume for Filler Metal Wires Covered By This MSDS (Weight %)

	Si	Ti	Al	Fe	Mn	Ni	Cr	Mo	Nb	Cu	Co
INCOLOY® 65	0.2	0.6	0.2	23	0.4	39	19	2	<0.1	2.8	-
INCONEL® 617	0.2	.0.3	0.7	1	0.6	40	16	8	<0.1	0.4	8
INCONEL® 625, 625T & 625TSW™	0.1	0.2	0.2	0.3	0.2	49	17	9	2	<0.1	-
INCONEL® 718 & 718TSW™	<0.1	0.9	0.6	15	0.4	44	15	3	3	0.4	-
INCONEL® 82 & 82T	0.3	0.3	0.2	1	6	56	15	<0.1	1	<0.1	-
INCO-WELD® C-276 & C276TSW™	0.1	<0.1	1	14	3	28	10	11	<0.1	0.8	-
MONEL® 60, 60N & 60TSW™	0.3	2	<0.1	2	5	47	<0.1	<0.1	<0.14	24	-
MONEL® 67 & 67N	0.4	1	0.6	2	2	10	<0.1	<0.1	<0.1	64	-
NC 80/20	0.4	0.1	0.1	0.4	2	57	16	<0.1	<0.1	0.6	-
Nickel 61 & 61N	<0.1	2	0.1	0.2	0.7	69	<0.1	<0.1	<0.1	1.3	-
NIMONIC® 263	0.2	2	0.4	0.7	0.7	43	17	5	<0.1	<0.1	14
NIMONIC® 90	1	1	2	3	0.4	35	15	<0.1	<0.1	0.4	9
NIMONIC® PE11	0.7	1	1	24	1	30	15	2	<0.1	0.4	-
NI-ROD® 44	<0.1	0.3	0.2	32	16	30	<0.1	<0.1	<0.1	<0.1	-
NI-ROD® 55	0.8	<0.1	0.1	33	4	31	<0.1	<0.1	<0.1	<0.1	-

Table 3.2
Composition of Welding Fume for Flux Coated Welding Electrodes Covered By This MSDS (Weight %)

	Ni	Cr Total	Cr 6	Fe	Mn	Cu	Co	Ti	Ba	F
INCOLOY® 135	0.88	3.13	0.91	2.15	2.99	0.60	0.02	3.51	<0.1	21.3
INCONEL® 112 & 112T	1.95	2.80	0.79	0.76	0.16	0.06	0.03	2.58	<0.1	26.7
INCONEL® 117	2.32	3.14	0.93	0.54	0.84	0.03	0.91	1.05	<0.1	28.4
INCONEL® 182 & 182T	1.59	2.14	0.55	0.94	10.5	0.06	0.03	3.29	<0.1	23.2
INCO-WELD® A	2.10	2.33	0.61	1.00	1.62	0.03	0.03	0.23	0.90	29.3
INCO-WELD® B	4.18	3.70	1.1	2.62	3.80	0.15	0.03	0.22	<0.1	20.9
INCO-WELD® C	0.77	4.38	1.49	9.62	3.19	0.09	0.20	2.91	<0.1	11.6
INCO-WELD® C-276	5.0	4.0	2.7	2.0	2.0	0.2	-	3.0	<0.1	-
MONEL® 187 & 187N	0.76	0.02	<0.01	0.42	2.33	10.7	0.03	3.36	2.90	30.4
MONEL® 190 & 190N	1.79	0.04	<0.01	0.26	2.43	8.7	0.04	1.23	1.83	24.9
Nickel 141 & 141N	3.15	0.02	<0.01	.56	.60	0.02	0.03	1.91	<0.01	30.2
NI-ROD©	13.9	0.01	0.01	3.77	0.27	0.02	0.05	0.64	<0.1	8.4
NI-ROD® 44	2.41	0.03	0.01	9.73	11.8	1.40	0.02	0.13	7.25	3.4
NI-ROD® 55	2.1	0.03	0.01	1.45	0.37	0.02	0.02	0.23	0.49	3.1
NI-ROD® 55X	1.23	0.02	<0.01	5.30	1.14	1.40	0.03	0.10	9.88	3.0
NI-ROD® 99X	3.23	0.03	<0.01	3.21	3.69	1.29	0.04	0.03	8.30	5

Table 3.3
Composition of Welding Fume for Flux-Cored Welding Wires Covered By This MSDS (Weight %)

	Si	Ti	Al	Fe	Mn	Ni	Cr	Mo	Nb	Cu
NI-ROD© FC55	1	0.3	3	13	7	13	<0.1	<0.1	<0.1	0.2

Table 3.4
Composition of Welding Fume for Stainless Steel Welding Wires Covered By This MSDS (Weight %)

	Fe	Mn	Ni	Cr	Cu	Mo
INCO-WELD© 308, 308H, 308L, 308LSi	40.30	4.10	6.30	11.10	0.16	0.06
INCO-WELD© 309, 309H, 309L, 309LSi	33.50	7.00	7.00	16.30	0.16	0.33
INCO-WELD© 310	34.50	4.20	10.00	16.50	0.16	0.06
INCO-WELD© 312	34.00	7.10	6.20	18.50	0.10	0.06
INCO-WELD© 316, 316L, 316LSi	31.00	7.10	6.50	8.50	0.70	1.80
INCO-WELD© 347	34.5	5.70	6.20	10.20	0.17	0.14
318	31.00	7	6.5	9	0.16	1.8
410	35	3		5.5		
18/8/Mn	40.3	8.20	6.20	11.20	0.15	1.06

Table 3.5
Composition of Welding Fume For Low Alloy Steel Welding Wires Covered By This MSDS (Weight %)

	Fe	Mn	Ni	Cr	Cu	Pb
A15 / A18	55	6.5			1.1	
A31	62	16			1.5	
A32	55	9	0.2	1.5	2	03
A33	53	6	0.3	2	2.2	0.5

Table 3.6
Composition of Welding Fume for Aluminum Alloy Welding Wires Covered By This MSDS

	Fe	Mn	Ni	Cr	Cu	Al_2O_3
INCO-WELD© 1050	1	0.1			0.2	90
INCO-WELD© 4043	2	0.1			0.40	80
INCO-WELD© 4047	2	0.1			0.4	80
INCO-WELD© 5356	1	0.1			0.50	83
INCO-WELD© 5556	1	0.1			0.40	80

Table 3.7
Composition of Welding Fume for Copper Alloy Welding Wires Covered By This MSDS

	Fe	Mn	Ni	Cr	Cu
INCO-WELD© Cu	0.30	0.60	0.10	0.10	75
INCO-WELD© CuSi-A	0.20	1.00	0.20	0.10	73
INCO-WELD© C12	0.30	0.10	0.10	0.10	75
INCO-WELD© C13	2.00	0.10	0.20	0.10	80
INCO-WELD© C26	5.0	1.00	0.50	0.10	75

Appendix 1

INGREDIENTS, TOXICOLOGICAL AND EXPOSURE LIMIT INFORMATION

The following information is primarily directed to the ingredients of the complex alloys listed in table 2.1, 2.2, 2.3, 2.5, 2.6, and 2.7. Although it is the user's responsibility to assess end products, intermediates, or fugitive emissions arising out of the use of these alloys, information is also provided for common fume ingredients. *UK EH40 limits for the ingredients are shown in italics at the end of each section.*

Ingredient		EINECS Number	CAS Number	Exposure Limits[(1)]:	Comments
Symbol	**Name**				
Al	Aluminum		7429-90-5	TLV: 10 mg/m³ (Metal dust); 5 mg/m³ (Welding fumes) PEL: 15 mg/m³ (Total metal dust); 5 mg/m³ (Metal dust – respirable fraction) LD_{50}: Not Available *EH40 - Aluminum metal: Total inhalable dust OES 10 mg/m³ (8 hours TWA),Total respirable dust OES 4 mg/m³ (8 hours TWA)*	Aluminum is not readily absorbed through the skin or the GI tract and only poorly through the lungs. Foreign literature between 1958 and 1962 reported cases of severe and sometimes fatal pulmonary fibrosis in workers exposed to aluminum dust. In one of the fatal cases, the worker developed fibrosis and encephalopathy after 13.5 years of exposure to aluminum dust. In rodent studies and currently in US industry, no fibrosis or encephalopathy have been reported from the inhalation of aluminum powder. Acute exposure to alumina fume may cause bronchial irritation; however reports of pulmonary fibrosis and emphysema in alumina abrasive workers are no longer seen, owing to improved environmental control.
Al_2O_3	Aluminum Oxide (Alumina)		1344-28-1	TLV: 10 mg/m³ PEL: 15 mg/m³ (Total dust); 5 mg/m³ (respirable) LD50: Not Available *EH40 Total inhalable dust OES 10 mg/m³ (8 hours TWA),Total respirable dust OES 4 mg/m³ (8 hours TWA)*	Acute exposure to this material may cause bronchial irritation; however reports of pulmonary fibrosis and emphysema of alumina abrasive workers are no longer seen, owing to improved environmental control.
$BaCO_3$	Barium Carbonate		513-77-9	TLV: 0.5 mg/m³ (Soluble compounds, as Ba) PEL: 0.5 mg/m³ (Soluble compounds, as Ba) LD50: 418 mg/kg, rat, oral *EH40 OES 0.5 mg/m³ (soluble compounds, as Ba)*	Excessive inhalation can produce a benign pneumoconiosis called Baritosis. Ingestion can cause excessive salivation, vomiting, colic, violent diarrhea, convulsive tremors progressing to muscular paralysis, increased blood pressure, internal hemorrhages in the kidneys and G.I tract, and possible hypokalemia.
BaF_2	Barium Flouride		7787-32-8	TLV: 0.5 mg/m³ (Soluble compounds, as Ba) PEL: 0.5 mg/m³ (Soluble compounds, as Ba) LD50: 250 mg/kg, rat, oral *EH40 OES 0.5 mg/m³ (soluble compounds, as Ba)*	Inhalation may cause irritation of the respiratory tract. Ingestion can cause severe gastrointestinal distress with vomiting, diarrhea, and abdominal pain. Barium and fluoride absorption can result in muscle (including cardiac) and nerve irregularities with potassium and calcium deficiencies. Chronic exposures may cause Fluorosis (Chronic fluoride intoxication) with symptoms of digestive disturbances such as vomiting, loss of appetite, diarrhea, or constipation.
C	Carbon		7440-44-0	TLV: 3.5 mg/m³ (As carbon black) PEL: 3.5 mg/m³ (As carbon black) LD50: 440 mg/kg, mouse, intravenous	Inhalation that is prolonged and repeated at excessive levels may lead to benign pneumoconiosis. No effects have been found for ingestion.
$CaCO_3$	Calcium Carbonate		1317-65-3	TLV: 10 mg/m³ PEL: 15 mg/m³ (Total dust); 5 mg/ m³ (Respirable fraction) LD50: 6,450 mg/kg, rat, oral *EH40: Total inhalable dust OES 10 mg/m³ (8 hours TWA),Total respirable dust OES 4 mg/m³ (8 hours TWA)*	This compound is considered non-toxic. Inhalation of particulates could cause mild irritation of the respiratory tract. Though used as an antacid, ingestion of large amounts could lead to intestinal blockage.

CaF_2	Calcium Fluoride (Fluorspar)		7789-75-5	TLV: 2.5 mg/m³ (as F) PEL: 2.5mg/m³ (as F) LD_{50}: 4,250mg/kg, rat, oral	Inhalation of welding fumes containing calcium fluoride can cause irritation of the respiratory tract. Ingestion of soluble fluorides can produce symptoms of vomiting, abdominal pain, diarrhea, convulsions, muscular weakness and other signs of neurological problems. Chronic exposures may cause Fluorosis (Chronic fluoride intoxication) with symptoms of digestive disturbances such as vomiting, loss of appetite, diarrhea, or constipation.
CaO	Calcium Oxide		1305-78-8	TLV: 2 mg/m³, as Calcium Oxide PEL: 5 mg/m³, as Calcium Oxide LD50: Not Known *EH40: Total inhalable dust OES 2 mg/m³ (8 hours TWA*	May cause skin, eye and mucous membrane irritation. Inhalation of dust or fume may cause respiratory irritation. Repeated exposure can cause damage to the nasal septum, pneumonia and dermatitis.
$CaSiO_3$	Calcium Metasilicate		1344-95-2	TLV: 10 mg/m³ (Dust) PEL: 15 mg/m³ (Total dust) 5 mg/m³ (Respirable) LD_{50}: Not Available *EH40: Total inhalable dust OES 10 mg/m³ (8 hours TWA),Total respirable dust OES 4 mg/m³ (8 hours TWA)*	Long Term cumulative inhalation of calcium metasilicate may cause restriction of the large airways. May cause minor skin and eye irritation. The International Agency for Research on Cancer (IARC) has concluded that calcium metasilicate is a questionable carcinogen with experimental tumorigenic data in animals. Not classifiable as a human carcinogen according to IARC.
Co	Cobalt	231-158-0	7440-48-4	TLV: 0.02 mg/m³ (Dust & fume as Co) PEL: 0.1 mg/m³ (As Co metal) LD_{50}: 6,170 mg/kg, rat, oral *EH40 OES 0.1 mg/m³ (8 hours TWA)*	Asthmatic symptoms and pulmonary fibrosis occurring in the tungsten carbide industry may be related to the inhalation of metallic cobalt dust. Evidence of polycythemia (an increase in the total red cell mass of the blood in the body) and altered thyroid, kidney and liver function have also been found. Excessive inhalation of metallic cobalt has produced cardiac changes in miniature swine. Eye contact may cause conjunctivitis. Symptoms of excessive ingestion may be a sensation of hotness with vomiting, diarrhea and nausea along with the potential for causing damage to blood, heart, thyroid and pancreas. Repeated skin contact can cause sensitivity and allergic skin rashes. Cobalt powders have caused tumors at the site of injection in rodents. However, studies of cobalt-containing prostheses do not suggest a significant risk for humans.
Cr	Chromium	231-157-5	7440-47-3	TLV: 0.5 mg/m³ PEL: 1.0 mg/m³ (Metal as Cr) LD_{50}: Not Available *EH40:* *Chromium VI compounds (as Cr)* *OES 0.05 mg/m³ (8 hours TWA)* *Chromium II compounds (as Cr)* *OES 0.5 mg/m³ (8 hours TWA)* *Chromium III compounds (as Cr)* *OES 0.5 mg/m³ (8 hours TWA)* *Chromium* *OES 0.5 mg/m³ (8 hours TWA)*	Chromium metal is relatively nontoxic. Chromium metal and insoluble salts are said to be involved in fibrosis of the lungs. When the metal is heated to a high temperature, fumes produced may be damaging to the lungs if inhaled. The International Agency for Research on Cancer has concluded that the evidence for carcinogenicity in humans and animals is inadequate for chromium metal and trivalent chromium compounds, but sufficient for hexavalent chromium compounds. Fumes from welding chromium-containing stainless steel or certain chromium-containing rods can trigger eczematous eruptions on the palms of the hands of chromium-sensitized individuals.
Cr_2O_3	Chromic Oxide		1308-38-9	TLV: 0.5 mg/m³, as Cr PEL: 0.5 mg/m³ (Metal as Cr) LD50: Not Available	Trivalent chromium compounds (such as Cr2O3) are considered to exhibit a low degree of toxicity. Excessive concentrations of airborne dust may irritate the nose, throat, and respiratory tract. Prolonged overexposure may result in pulmonary changes. Skin and eye contact may cause irritation. The U.S. National Toxicology Program (NTP) has concluded that there is sufficient evidence that certain chromium compounds were carcinogenic to humans. However, the International Agency for Research on Cancer (IARC) has stated that there is inadequate evidence for carcinogenicity to humans or animals for trivalent chromium compounds.

Cu	Copper	231-159-6	7440-50-8	TLV: 1 mg/m³ (Dusts & mists, as Cu), 0.2 mg/m³ (Fume) PEL: 1 mg/m³ (Dusts & mists, as Cu), 0.1 mg/m³ (Fume as Cu) LD_{50}: 35 mg/kg, mouse, intraperitoneal *EH40: Fume OES 0.2 mg/m³ (8 hours TWA)* *Dusts & mists (as Cu) OES 1.0 mg/m³ (8 hours TWA), 2.0 mg/m³ (15 minute reference period)*	Copper metal dust and fume may be irritating to the respiratory tract. In user operations where copper fume is generated, inhalation of the fume can result in symptoms of "Metal Fume Fever" such as chills, fever and sweating. A few instances of allergic skin rashes have been reported in workers with skin exposure to metallic copper. In the eyes, copper metal as a foreign body can provoke an inflammatory reaction resulting in pus formation in the conjunctiva, cornea or sclera. Ingestion of copper metal may cause gastrointestinal upset. Wilson's disease can occur in certain individuals with a rare, inherited metabolic disorder characterized by retention of excessive amounts of copper in the liver, brain, kidneys and corneas. These deposits eventually lead to tissue necrosis and fibrosis, causing a variety of clinical effects, especially liver disease and neurological changes. Wilson's disease is progressive and, if untreated, leads to fatal liver failure.
Fe/ Fe_2O_3	Iron	231-096-4	7439-89-6	TLV: No limit set (For Fe_2O_3 fume the TLV is 5 mg/m³ as Fe) PEL: No limit set (For Fe_2O_3 dust & fume the PEL is 10 mg/m³ as Fe) LD_{50}: Not Available *EH40 Iron Oxide, fume (as Fe) OES 5.0 mg/m³ (8 hours TWA), 10 mg/m³ (15 minute reference period)*	Inhalation of the excessive oxide fumes or dusts can lead to irritation of the respiratory tract. Prolonged inhalation of iron oxide for periods of 6 to 10 years is known to cause siderosis which appears to be a benign pneumoconiosis. Prolonged eye contact with the metal dust could cause rust brown colored spots forming around the particles and if left for several years, permanent damage could result.
Fe_3O_4	Ferrosoferric Oxide		1317-61-9	TLV: No limit set (For Fe_2O_3 fume, 5 mg/m_3 as Fe) PEL: No limit set (For Fe_2O_3 dust and fume, 5 mg/m³ as Fe) LD50: Not Available	Inhalation of excessive amounts can lead to irritation of the respiratory tract. Chronic inhalation of iron oxide for periods of 6 - 10 years is known to cause siderosis which seems to be a benign pneumoconiosis. No data found on ingestion.
K_2O	Potassium Oxide		12136-45-7	TLV: 2 mg/m³ Ceiling value as KOH PEL: 2 mg/m³ Ceiling value as KOH LD50: Not Available	No toxicity data was found on potassium oxide, but it is expected to have effects similar to sodium peroxide which is highly irritating to the skin, eyes and the mucous membranes of the respiratory tract.
K_2SiO_3	Potasium Silicate		1312-76-1	TLV: Not Established PEL: Not Established LD50: >1000 mg/kg, oral, rat	Silicates are generally considered to have low systemic toxicity, however due to their alkaline nature they may cause corrosive effects on mucous membranes. Eye exposure can cause irritation, redness, tearing and blurred vision. Prolonged eye exposure may lead to chronic conjunctivitis. Skin exposure may cause local slight irritation. Repeated contact may lead to dermatitis. Inhalation of mist or fume can cause irritation of the nasal and respiratory passages. Ingestion can produce gastrointestinal irritation, nausea, vomiting, diarrhea, accompanied by potentially severe tissue damage. No known chronic effects have been noted.
K_2ZrF_6	Potassium Fluozirconate		16923-95-8	TLV: 2.5 mg/m³ (Fluorides, as F) PEL: 2.5 mg/m³ (Fluorides, as F) LD50: 98 mg/kg, mouse, oral	Inhalation of welding fumes containing fluorides can cause irritation of the respiratory tract. Ingestion of soluble fluorides can produce symptoms of vomiting, abdominal pain, diarrhea, convulsions, muscular weakness and other signs of neurological problems. Nose bleeds, skin irritation, tissue damage and slow healing scars can result if exposure is excessive. Chronic exposures may cause Fluorosis (Chronic fluoride intoxication) with symptoms of digestive disturbances such as vomiting, loss of appetite, diarrhea, or constipation.

$LiCO_3$ Li_2CO_3	Lithium Carbonate		554-13-2	TLV: No limit set PEL: No limit set LD50: Oral 525 mg/kg, rat Dermal LD 50, > 2000 mg/kg, rat	Contact with skin or eyes may cause irritation. Ingestion may cause acute local tissue damage. Some studies of pregnant mice and rats indicated an association between lithium ingestion and birth defects but only at dose levels large enough to produce signs of severe maternal toxicity. Although data for the 1970's and early 1980's suggested an increase in cardiovascular defects in babies born to women on lithium carbonate therapy, more recent studies have not found any association between lithium exposure and birth defects. Exposure to lithium in industrial settings is not considered to pose a risk to human health. NIOSH studied 25 workers exposed to lithium-containing dust at air concentrations exceeding 10 Mg/M3 (nuisance dust limit) and found that typical industrial exposure to lithium will not result in blood levels sufficiently high to produce toxicity in either adults or their offspring.
MgO	Magnesium Oxide		1309-48-4	TLV: 10 mg/m³ (As fume) PEL: 15 mg/m³ (Total dust or fume) LD50: Not Available *EH40 Total inhalable dust OES 10 mg/m³ (8 hours TWA),Total fume and respirable dust OES 4 mg/m³ (8 hours TWA)*	Inhalation of fumes can irritate the nose and throat. Excessive inhalation can cause metal fume fever with flue-like symptoms such as fever, body aches, vomiting, etc. Fumes of magnesium may irritate the eyes and skin. On ingestion the oxide will act as an antacid and laxative.
Mn	Manganese	231-105-1	7439-96-5	TLV: 0.2 mg/m³ elemental and inorganic compounds, as Mn PEL: 5 mg/m³ (Ceiling, as Mn compounds); 5 mg/m³ (Fume, as Mn) LD_{50}: 9,000 mg/kg, rat, oral *EH40 Manganese and its inorganic compounds (as Mn) OES 0.5 mg/m³ (8 hours TWA)*	Excessive inhalation or ingestion of manganese can produce manganese poisoning. Chronic exposures can lead to neurological problems such as apathy, drowsiness, weakness, spastic gait, paralysis, and other neurological problems resembling Parkinsonism. These symptoms can become progressive and permanent if not treated. Excessive inhalation of fumes may cause "Metal Fume Fever" with its flu-like symptoms, such as chills, fever, body aches, vomiting, sweating, etc.
MnO	Manganous Oxide		1344-43-0	TLV: 0.2 mg/m³ (as Mn) PEL: 1mg/m³ (fume) 5mg/m³(Stel, Ceiling) LD_{50}: >50mg/kg, intratracheal rat.	Excessive inhalation or ingestion of manganese and manganese compounds can produce manganese poisoning. Chronic exposures can lead to neurological problems such as apathy, drowsiness, weakness, spastic gait, paralysis, and other neurological problems resembling Parkinsonism. These symptoms can become progressive and permanent if not treated. Inhalation of fumes may bring about "metal fume fever" with symptoms such as chills and fever, upset stomach, vomiting, dryness of throat, cough, weakness, and aching of the head and body.
Mo	Molybdenum	231-107-2	7439-96-7	TLV: 10 mg/m³ (Insoluble and metal compounds, as Mo) PEL: 15 mg/m³ (Insoluble compounds, total dust as Mo) LD_{50}: Not Available *EH40 - Molybdenum compounds (as Mo):* *Soluble - OES 5.0 mg/m³ (8 hours TWA), 10 mg/m³ (15 minute reference period)* *Insoluble - OES 10 mg/m³ (8 hours TWA), 20 mg/m³ (15 minute reference period)*	Molybdenum and its insoluble compounds are reported to have a low toxicity. High dietary intake may produce a gout-like disease and high blood uric acid. Inhalation of fumes has caused kidney damage, respiratory irritation and liver damage in animals. Skin and eye contact may cause irritation.

Na_20	Sodium Oxide		1313-59-3	TLV: 2 mg/m³ (ceiling level as NaOH) PEL: 2mg/m³ (as NaOH) LD_{50}: Not Available	Sodium oxide, in powder form, is highly corrosive to moist skin, eyes, and the mucous membranes of the digestive and respiratory tracts due to its reaction with water to form sodium hydroxide. Inhalation of dusts may cause symptoms that vary from mild irritation to destructive burns depending on exposure. Ingestion can cause immediate burning of the mouth, esophagus, and stomach; swelling of surround tissues, vomiting; and rapid, faint pulse with cold, clammy skin. Death can result. Skin contact causes slippery, soapy feeling that may not be immediately painful even though skin damage begins at contact. This contact can lead to chemical burns, tissue corrosion, ulceration, loss of nails and hair, and permanent scarring if not immediately washed off. The cornea of the eye will begin corroding on contact and can lead to temporary or permanent corneal opacification producing blindness. Chronic low level skin exposures to sodium hydroxide may result in dermatitis. Sodium hydroxide is reported to have caused carcinoma of the esophagus 12 to 42 years after ingestion.
$Na_2Si_4O_9$/ Na_2Si0_3	Sodium Silicate		1344-09-8	TLV: Not Established PEL: Not Established LD50: 1153 mg/kg, oral, rat	Silicates are generally considered to have low systemic toxicity, however due to their alkaline nature they may cause corrosive effects on mucous membranes. Eye exposure can cause severe irritation, redness, tearing and blurred vision. Skin exposure may cause slight irritation. Inhalation of mist or fume can cause irritation of the nasal and respiratory passages. Ingestion may produce gastrointestinal irritation, nausea, vomiting, diarrhea and abnormal kidney function. No known chronic effects have been noted.
Na_2AlF_6	Sodium Aluminum Fluoride (Sodium Fluoaluminate)		15096-52-3	TLV: No limit set PEL: No limit set LD50: 200 mg/kg, rat, oral	Excessive inhalation of dust may cause irritation of the nose, throat and respiratory tract. Ingestion causes severe gastrointestinal distress with salivation, nausea, vomiting, diarrhea, and pain. Also may cause muscular weakness, tremors, convulsions, loss of consciousness, and death. Prolonged exposure to fluorides can cause skeletal abnormalities and digestive tract disturbances. Prolonged or repeated skin contact can produce dermatitis.
NaF	Sodium Flouride		7681-49-4	TLV: 2.5 mg/m³ (as F) PEL: 2.5 mg/m³ (as F) LD_{50}: 0.18g/kg, rat, oral	Sodium fluoride is very poisonous. Ingestion of less than 1 gram can cause nausea and vomiting, salivation, diarrhea, weakness, spasms of limbs, and stupor. Ingestion of 5 to 10 grams has proven fatal. Symptoms of possible lethal exposure include muscular weakness, tremors, convulsions, collapse, and difficulty breathing to respiratory and cardiac failure. This chemical is irritating to the eyes, nose and respiratory system. Long-term exposure can cause skeletal abnormalities (Fluorosis) to develop. This can include bone densification and calcification of certain ligaments along with stiffness of the spinal column. Mottling of tooth enamel is also possible.
Nb	Niobium	231-113-5	7440-03-1	TLV: No limit set PEL: No limit set LD_{50}: Not Available	Also known as Columbium (Cb), there is almost no information on the toxicity of this metal or its fumes. Russian medical literature has described early chest x-ray changes in welders and chemical workers handling niobium and tantalum, but no specific data has been found. It is expected that the metal dust and fumes could cause irritation to the skin, eyes and respiratory tract upon acute exposure.

Ni	Nickel R43	231-111-4	7440-02-0	TLV: 1.5 mg/m³ as metal (Inhalable Fraction) PEL: 1 mg/m³ for metal and insoluble compounds as Ni LD_{50}: >9,000 mg/kg, rat, oral *EH40 - Nickel and its inorganic compounds (except nickel carbonyl): Water soluble nickel compounds (as nickel) OES 0.1 mg/m³ (8hours TWA). Nickel & water in-soluble nickel compounds (as Ni) OES 0.5 mg/m³(8-hour TWA)*	The U.S. National Toxicology Program (NTP) 10th Report on Carcinogens has listed "metallic nickel" as "reasonably anticipated to be a human carcinogen" and "nickel compounds" as "known human carcinogens". "Nickel Alloys" were reviewed but not listed. The International Agency for Research on Cancer (IARC) concluded that nickel compounds were carcinogenic to humans and that metallic nickel is possibly carcinogenic to humans. Epidemiological studies of workers exposed to nickel powder and to dust and fume generated in the production of nickel alloys and of stainless steel have not indicated the presence of a significant respiratory cancer hazard. The inhalation of nickel powder has not resulted in an increased incidence of malignant tumors in rodents. Repeated intratracheal instillation of nickel powder produced an increased incidence of malignant lung tumors in rats, but did not produce an increased incidence in hamsters when administered at the maximum tolerated dose. However, single intratracheal instillations of nickel powder in hamsters at doses near the LD_{50} have produced an increased incidence of fibrosarcomas, mesotheliomas and rhabdomyosarcomas. Inhalation of nickel powder at concentrations 15 times the PEL irritated the respiratory tract in rodents. Nickel is a known sensitizer and may produce allergic reactions.
Si	Silicon	231-130-8	7440-21-3	TLV: 10 mg/m³ PEL: 10 mg/m³ Total dust; 5 mg/m³ Respirable fraction LD50: 3,160 mg/kg, rat, oral in amorphous form *EH40 Total inhalable dust OES 10 mg/m³ (8 hours TWA). Total respirable dust OES 4 mg/m³ (8 hours TWA).*	Silicon in dust form is considered a nuisance dust with no toxic effects when exposures are kept under control. However, like all dusts, high concentrations of silicon dust will cause some irritation to the nose and throat. Inhalation of crystalline silica (SiO2) over a long period of time can cause silicosis. In 1997, the International Agency for Research on Cancer (IARC) concluded that crystalline silica is a class I carcinogen. IARC states that a number of studies have shown that persons diagnosed as having silicosis have an increased risk of dying from lung cancer.
SiO_2	Silicon Dioxide Silica		60676-86-0	TLV: 10 mg/m³ (Metal dust); 5 mg/m³ (Welding fumes) PEL: 15 mg/m³ (Total metal dust); 5 mg/m³ (Metal dust - respirable fraction) LD_{50}: Not Available *EH40: Silica, fused respirable dust, OES 0.08 mg/m³ (8-hour TWA)*	No information was found on the hazards of ingestion of crystalline silica as the material seems to be relatively inert. Acute exposures to this material will irritate the respiratory tract. Chronic inhalation (after 10 - 20 years) can produce silicosis pneumoconiosis of the lungs) with symptoms of dyspnea, cough, wheezing and repeated, non-specific chest illnesses. Impairment of pulmonary function may be progressive. In 1997, the International Agency for Research on Cancer (IARC) concluded that crystalline silica is a class 1 carcinogen. IARC states that a number of studies have shown that persons diagnosed as having silicosis have an increased risk of dying from lung cancer.
$SrCO_3$	Strontium Carbonate		1633-05-2	TLV: No limit set PEL: No limit set LD50: Not Available	There is very little toxicity and health data on this material. Excessive overexposure to the dust may ulcerate mucous membranes in the nose and may cause sneezing and coughing. No data found on ingestion problems.
Ti	Titanium	231-142-3	7440-32-6	TLV: No limit set PEL: No limit set LD_{50}: Not Available *EH40 - As Titanium dioxide: Total inhalable dust OES 10 mg/m³ (8 hours TWA), Total respirable dust OES 4 mg/m³ (8 hours TWA)*	Inhalation of titanium could cause mild irritation to the respiratory tract. Inhalation of titanium dioxide dust or fume could produce lung fibrosis and chronic bronchitis.

Ta	Tantalum		7440-25-7	TLV: 5 mg/m³ (Metal & oxide dusts) PEL: 5 mg/m³ (Metal & oxide dusts) LD_{50}: Not Available *EH40 OES 5.0 mg/m³ (8 hours TWA), 10 mg/m³ (15 minute reference period)*	There are no reports of adverse health effects in industrially exposed workers. Massive doses of tantalum given by the intratracheal route to rats have produced respiratory tract lesions. In contact with tissue, metallic tantalum is inert. Tantalum pentoxide has an LD_{50} of >8 g/kg, orally in rats.
TiO_2	Titanium Dioxide		13463-67-7	TLV: 10 mg/m³ (Dust); PEL: 5 mg/m³ (Respirable) LD_{50}: Not Available *EH40: Total inhalable dust OES 10.0 mg/m³(8-hour TWA), total respirable OES 4 mg/m³*	Is considered a nuisance dust that is inert, practically non-toxic and chemically non-irritating. Skin contact has shown no problems other than possible drying and mechanical abrasion. Eye contact can produce particulate irritation. Does not seem to be absorbed by the body through ingestion. Excessive inhalation can produce mild pulmonary irritation and possible non-disabling slight fibrosis of the lungs.
W	Tungsten	231-143-9	7440-33-7	TLV: 5 mg/m³ insoluble compounds, as W STEL: 10 mg/m³ for soluble compounds, as W PEL: No limit set LD_{50}: 2,000mg/kg, rat, unreported route *EH40: Soluble compounds, OES 1.0 mg/m³ (8-hour TWA) and 3 mg/m³ (15 minute reference period).* *In-soluble compounds, OES 5 mg/m³(8-hour TWA) and 10.0 mg/m3 (15 minutes reference period)*	Inhalation of tungsten dust may cause irritation of the respiratory tract. Skin or eye contact could cause abrasion or irritation of the respective surfaces. No hazards have been identified for tungsten fume except that it may aggravate an existing chronic respiratory disease.
$Zr0_2$	Zirconium Dioxide		1314-23-4	TLV: 5 mg/m³ (as Zr) 10 mg/m³ (STEL) PEL: 5 mg/m³ (as Zr) 10 mg/m³ (STEL) LD_{50}: Not Available *EH40 Zirconium compounds (as Zr), OES 5mg/m³ (8-hour TWA), 10 mg/m³ (15-minute reference period*	Though this material has a low order of toxicity on inhalation some lung granulomas have been reported. Excessive inhalation may cause irritation of the nose and respiratory tract. Eye contact may cause irritation. Skin contact may cause irritation and sensitization dermatitis characterized by dusty red-brown papules. No information found on effects of ingestion.

Notes: (1) TLV = Threshold Limit Values - American Conference of Governmental Industrial Hygienists
PEL = Permissible Exposure Limit - OSHA 29 CFR 1910.1000
C = Ceiling value
STEL = Short Term Exposure Limit - a time-weighted 15-minute exposure limit, not to be exceeded at any time during a workday.

(2) CAS No. = Chemical Abstracts Services Number

Trace impurities and additional material names not listed above may also appear in Appendix 1 toward the end of the MSDS. These materials may be listed for local “Right-To-Know” compliance and for other reasons.

Weight percentages for each grade of product are listed in Table 2.x

Safety Data Sheet

Section 1: Identification of the Substance/Mixture and of the Company/Undertaking

1.1 Product identifier

Product Name • **Monel Based Alloys**

Synonyms • (X) Monel; CuNi; Monel (X)

1.2 Relevant identified uses of the substance or mixture and uses advised against

Relevant identified use(s) • Cast ingots at varying weights and dimensions. Ingots are sold and distributed to downstream processors who remelt the superalloys into products used within various downstream applications.

1.3 Details of the supplier of the safety data sheet

Manufacturer • Doncasters US Holdings, Inc.

3245 Cherry Avenue
Long Beach, CA 90807
United States

Telephone (General) • 860-677-1376

Telephone (Technical) • 562-595-6625

1.4 Emergency telephone number

Manufacturer • 800-262-8200 - CHEMTREC

Manufacturer • +1-703-741-5500 - CHEMTREC

Section 2: Hazards Identification

EU/EEC

According to: Regulation (EC) No 1272/2008 (CLP)/REACH 1907/2006 [amended by 2015/830]

2.1 Classification of the substance or mixture

CLP • Skin Sensitization 1 - H317
Respiratory Sensitization 1 - H334
Specific Target Organ Toxicity Single Exposure 3: Respiratory Tract Irritation - H335
Carcinogenicity 2 - H351
Reproductive Toxicity 1B - H360D
Specific Target Organ Toxicity Single Exposure 1 - H370
Specific Target Organ Toxicity Repeated Exposure 1 - H372
Specific Target Organ Toxicity Repeated Exposure 2 - H373

2.2 Label Elements

CLP

DANGER

Hazard statements

- H317 - May cause an allergic skin reaction
  H334 - May cause allergy or asthma symptoms or breathing difficulties if inhaled
  H335 - May cause respiratory irritation
  H351 - Suspected of causing cancer.
  H360D - May damage the unborn child.
  H370 - Causes damage to organs.
  H372 - Causes damage to organs through prolonged or repeated exposure.
  H373 - May cause damage to organs through prolonged or repeated exposure.

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 or fume.
  P264 - Wash thoroughly after handling.
  P270 - Do not eat, drink or smoke when using this product.
  P271 - Use only outdoors or in a well-ventilated area.
  P272 - Contaminated work clothing should not be allowed out of the workplace.
  P280 - Wear protective gloves/protective clothing/eye protection/face protection.
  P284 - In case of inadequate ventilation wear respiratory protection.

Response

- P304+P340 - IF INHALED: Remove person to fresh air and keep comfortable for breathing.
  P312 - Call a POISON CENTER/doctor if you feel unwell.
  P302+P352 - IF ON SKIN: Wash with plenty of water.
  P321 - Specific treatment, see supplemental first aid information.
  P362+P364 - Take off contaminated clothing and wash it before reuse.
  P333+P313 - If skin irritation or rash occurs: Get medical advice/attention.
  P308+P311 - IF exposed or concerned: Call a POISON CENTER or doctor/physician.
  P308+P313 - IF exposed or concerned: Get medical advice/attention.
  P314 - Get medical advice/attention if you feel unwell.

Storage/Disposal

- P403+P233 - Store in a well-ventilated place. Keep container tightly closed.
  P405 - Store locked up.
  P501 - Dispose of content and/or container in accordance with local, regional, national, and/or international regulations.

2.3 Other Hazards

CLP

- May form combustible dust concentrations in air.
  Heating above the melting point releases metallic oxides which may cause metal fume fever by inhalation. The symptoms are shivering, fever, malaise and muscular pain.
  According to Regulation (EC) No. 1272/2008 (CLP) this material is considered hazardous.

UN GHS Revision 3

According to: UN Globally Harmonized System of Classification and Labelling of Chemicals (GHS): Third Revised Edition

2.1 Classification of the substance or mixture

UN GHS

- Skin Sensitization 1
  Respiratory Sensitization 1
  Specific Target Organ Toxicity Single Exposure 3: Respiratory Tract Irritation
  Carcinogenicity 2
  Reproductive Toxicity 1B
  Specific Target Organ Toxicity Single Exposure 1
  Specific Target Organ Toxicity Repeated Exposure 1
  Specific Target Organ Toxicity Repeated Exposure 2

2.2 Label elements

UN GHS

DANGER

Hazard statements •
May cause an allergic skin reaction
May cause allergy or asthma symptoms or breathing difficulties if inhaled
May cause respiratory irritation
Suspected of causing cancer.
May damage fertility or the unborn child.
Causes damage to organs.
Causes damage to organs through prolonged or repeated exposure.
May cause damage to organs through prolonged or repeated exposure.

Precautionary statements

Prevention •
Obtain special instructions before use.
Do not handle until all safety precautions have been read and understood.
Do not breathe dust or fume.
Wash thoroughly after handling.
Do not eat, drink or smoke when using this product.
Use only outdoors or in a well-ventilated area.
Contaminated work clothing should not be allowed out of the workplace.
Wear protective gloves/protective clothing/eye protection/face protection.
Use personal protective equipment as required.
In case of inadequate ventilation wear respiratory protection.

Response •
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
Call a POISON CENTER or doctor/physician.
IF ON SKIN: Wash with plenty of soap and water.
Specific treatment, see supplemental first aid information.
Wash contaminated clothing before reuse.
If skin irritation or rash occurs: Get medical advice/attention.
IF exposed: Call POISON CENTER or doctor/physician.
IF exposed or concerned: Get medical advice/attention.
Get medical advice/attention if you feel unwell.

Storage/Disposal •
Store in a well-ventilated place. Keep container tightly closed.
Store locked up.
Dispose of content and/or container in accordance with local, regional, national, and/or international regulations.

2.3 Other hazards

UN GHS •
May form combustible dust concentrations in air.
Heating above the melting point releases metallic oxides which may cause metal fume fever by inhalation. The symptoms are shivering, fever, malaise and muscular pain.
According to the Globally Harmonized System for Classification and Labeling (GHS) this product is considered hazardous

United States (US)

According to: OSHA 29 CFR 1910.1200 HCS

2.1 Classification of the substance or mixture

OSHA HCS 2012 •
Skin Sensitization 1
Respiratory Sensitization 1
Specific Target Organ Toxicity Single Exposure 3: Respiratory Tract Irritation
Carcinogenicity 2
Reproductive Toxicity 1B
Specific Target Organ Toxicity Single Exposure 1
Specific Target Organ Toxicity Repeated Exposure 1
Specific Target Organ Toxicity Repeated Exposure 2
Combustible Dust

Hazards Not Otherwise Classified - Health Hazards - Metal fume fever

2.2 Label elements

OSHA HCS 2012

DANGER

Hazard statements

- May cause an allergic skin reaction
  May cause allergy or asthma symptoms or breathing difficulties if inhaled
  May cause respiratory irritation
  Suspected of causing cancer.
  May damage fertility or the unborn child.
  Causes damage to organs.
  Causes damage to organs through prolonged or repeated exposure.
  May cause damage to organs through prolonged or repeated exposure.
  May form combustible dust concentrations in air.

Precautionary statements

Prevention

- Obtain special instructions before use.
  Do not handle until all safety precautions have been read and understood.
  Do not breathe dust or fume.
  Wash thoroughly after handling.
  Do not eat, drink or smoke when using this product.
  Use only outdoors or in a well-ventilated area.
  Contaminated work clothing should not be allowed out of the workplace.
  Wear protective gloves/protective clothing/eye protection/face protection.
  In case of inadequate ventilation wear respiratory protection.

Response

- IF INHALED: Remove person to fresh air and keep comfortable for breathing.
  Call a POISON CENTER/doctor.
  If on skin: Wash with plenty of water.
  Specific treatment, see supplemental first aid information.
  Wash contaminated clothing before reuse.
  If skin irritation or rash occurs: Get medical advice/attention.
  IF exposed: Call POISON CENTER or doctor/physician.
  IF exposed or concerned: Get medical advice/attention.
  Get medical advice/attention if you feel unwell.

Storage/Disposal

- Store in a well-ventilated place. Keep container tightly closed.
  Store locked up.
  Dispose of content and/or container in accordance with local, regional, national, and/or international regulations.

2.3 Other hazards

OSHA HCS 2012

- Heating above the melting point releases metallic oxides which may cause metal fume fever by inhalation. The symptoms are shivering, fever, malaise and muscular pain.
  Under United States Regulations (29 CFR 1910.1200 - Hazard Communication Standard), this product is considered hazardous.

Canada

According to: WHMIS 2015

2.1 Classification of the substance or mixture

WHMIS 2015

- Skin Sensitization 1
  Respiratory Sensitization 1
  Specific Target Organ Toxicity Single Exposure 3: Respiratory Tract Irritation
  Carcinogenicity 2
  Reproductive Toxicity 1B
  Specific Target Organ Toxicity Single Exposure 1
  Specific Target Organ Toxicity Repeated Exposure 1

Specific Target Organ Toxicity Repeated Exposure 2
Combustible Dusts 1
Health Hazards Not Otherwise Classified 1

2.2 Label elements

WHMIS 2015

DANGER

Hazard statements

- May cause an allergic skin reaction
May cause allergy or asthma symptoms or breathing difficulties if inhaled
May cause respiratory irritation
Suspected of causing cancer.
May damage fertility or the unborn child.
Causes damage to organs.
Causes damage to organs through prolonged or repeated exposure.
May cause damage to organs through prolonged or repeated exposure.
May form combustible dust concentrations in air.
Heating above the melting point releases metallic oxides which may cause metal fume fever by inhalation. The symptoms are shivering, fever, malaise and muscular pain.

Precautionary statements

Prevention

- Obtain special instructions before use.
Do not handle until all safety precautions have been read and understood.
Do not breathe dust or fume.
Wash thoroughly after handling.
Do not eat, drink or smoke when using this product.
Use only outdoors or in a well-ventilated area.
Contaminated work clothing should not be allowed out of the workplace.
Wear protective gloves/protective clothing/eye protection/face protection.
In case of inadequate ventilation wear respiratory protection.

Response

- IF INHALED: Remove person to fresh air and keep comfortable for breathing.
Call a POISON CENTER/doctor if you feel unwell.
IF ON SKIN: Wash with plenty of water.
Take off contaminated clothing and wash it before reuse.
Specific treatment, see supplemental first aid information.
If skin irritation or rash occurs: Get medical advice/attention.
IF exposed or concerned: Call a POISON CENTER/doctor.
IF exposed or concerned: Get medical advice/attention.
Get medical advice/attention if you feel unwell.

Storage/Disposal

- Store in a well-ventilated place. Keep container tightly closed.
Store locked up.
Dispose of content and/or container in accordance with local, regional, national, and/or international regulations.

2.3 Other hazards

WHMIS 2015

- In Canada, the product mentioned above is considered hazardous under the Workplace Hazardous Materials Information System (WHMIS).

Section 3 - Composition/Information on Ingredients

3.1 Substances

- Material does not meet the criteria of a substance.

3.2 Mixtures

Composition					
Chemical Name	**Identifiers**	**%**	**LD50/LC50**	**Classifications According to Regulation/Directive**	**Comments**
Nickel	**CAS:**7440-02-0 **EC Number:**231-111-4	25% TO 70%	NDA	**EU CLP:** Annex VI, Table 3.1: Skin Sens. 1, H317; Carc. 2, H351 (Inhl); STOT RE 1, H372 (Lungs / Orl/Dermal/Inhl); Aquatic Chronic 3, H412 **UN GHS Revision 3:** Flam. Sol. 1; Resp. Sens. 1B; Skin Sens. 1A; Carc. 2 (Inhl); STOT RE 2 (Lungs / Orl, Inhl); Aquatic Acute 3; Aquatic Chronic 3 **OSHA HCS 2012:** Flam. Sol. 1; Comb. Dust; Resp. Sens. 1B; Skin Sens. 1A; Carc. 2 (Inhl); STOT RE 2 (Lungs / Orl, Inhl) **WHMIS 2015:** Flam. Sol. 1; Comb. Dust; Resp. Sens. 1B; Skin Sens. 1A; Carc. 2 (Inhl); STOT RE 2 (Lungs / Orl, Inhl)	NDA
Copper	**CAS:**7440-50-8 **EC Number:**231-159-6	20% TO 70%	NDA	**EU CLP:** Repr. 1B, H360D (Orl); STOT SE 1, H370 (Kidney, Orl); STOT SE 3: Resp. Irrit., H335; STOT RE 2, H373 (Liver, Orl); Aquatic Acute 1, H400 (M=100); Aquatic Chronic 1, H410 (M=10) **UN GHS Revision 3:** Repr. 1B (Orl); STOT SE 1 (Kidney, Orl); STOT SE 3: Resp. Irrit.; STOT RE 2 (Liver, Orl); Aquatic Acute 1 (M=100); Aquatic Chronic 1 (M=10) **OSHA HCS 2012:** Comb. Dust; Repr. 1B (Orl); STOT SE 1 (Kidney, Orl); STOT SE 3: Resp. Irrit.; STOT RE 2 (Liver, Orl); Hazard Not Otherwise Classified - Health Hazard - Metal Fume Fever **WHMIS 2015:** Comb. Dust; Repr. 1B (Orl); STOT SE 1 (Kidney, Orl); STOT SE 3: Resp. Irrit.; STOT RE 2 (Liver, Orl); Hazard Not Otherwise Classified - Health Hazard - Metal Fume Fever	NDA
Silicon	**CAS:**7440-21-3 **EC Number:**231-130-8	0% TO 8%	Ingestion/Oral-Rat LD50 • 3160 mg/kg	**EU CLP:** Flam. Sol. 2, H228 **UN GHS Revision 3:** Flam. Sol. 2; Acute Tox. 5 (Orl) **OSHA HCS 2012:** Flam. Sol. 2 **WHMIS 2015:** Flam. Sol. 2	NDA
Iron	**CAS:**7439-89-6 **EC Number:**231-096-4	0% TO 5%	NDA	**EU CLP:** Acute Tox. 4, H302; Aquatic Chronic 4, H413 **UN GHS Revision 3:** Acute Tox. 4 (Orl); Aquatic Chronic 4 **OSHA HCS 2012:** Acute Tox. 4 (Orl) **WHMIS 2015:** Acute Tox. 4 (Orl)	NDA
Aluminum	**CAS:**7429-90-5 **EC Number:**231-072-3	0% TO 5%	NDA	**EU CLP:** Annex VI, Table 3.1: Flam. Sol. 1, H228; Water-react. 2, H261 **UN GHS Revision 3:** Flam. Sol. 1; Water-react. 2; STOT RE 1 (Lungs / Inhl) **OSHA HCS 2012:** Flam. Sol. 1; Water-react. 2; Comb. Dust; STOT RE 1 (Lungs / Inhl) **WHMIS 2015:** Flam. Sol. 1; Water-react. 2; Comb. Dust; STOT RE 1 (Lungs / Inhl)	NDA
Manganese	**CAS:**7439-96-5 **EC Number:**231-105-1	0% TO 2%	Ingestion/Oral-Rat LD50 • 9 g/kg	**EU CLP:** Flam. Sol. 2, H228; Eye Irrit. 2, H319; Repr. 2, H361 (Orl); STOT RE 1 (CNS, Lungs / Inhl) **UN GHS Revision 3:** Flam. Sol. 2; Skin Irrit. 3; Eye Irrit. 2; Repr. 2 (Orl); STOT RE 1 (CNS, Lungs/ Inhl) **OSHA HCS 2012:** Flam. Sol. 2; Comb. Dust; Eye Irrit. 2; Repr. 2 (Orl); STOT RE 1 (CNS, Lungs / Inhl); Hazard Not Otherwise Classified - Health Hazard - Metal fume fever **WHMIS 2015:** Flam. Sol. 2; Comb. Dust; Eye Irrit. 2; Repr. 2 (Orl); STOT RE 1 (CNS, Lungs / Inhl); Hazard Not Otherwise Classified - Health Hazard - Metal fume fever	NDA
				EU CLP: Annex VI, Table 3.1: Resp. Sens. 1, H334; Skin	

Cobalt (powder)	**CAS:**7440-48-4 **EC Number:**231-158-0 **EU Index:**027-001-00-9	0% TO 2%	Ingestion/Oral-Rat LD50 • 6171 mg/kg	Sens. 1, H317; Aquatic Chronic 1, H410 (M=1) **UN GHS Revision 3:** Eye Irrit. 2; Resp. Sens. 1; Skin Sens. 1; Carc. 2 (Inhl); STOT RE 2 (Lung / Inhl); Aquatic Acute 2; Aquatic Chronic 2 **OSHA HCS 2012:** Eye Irrit. 2; Resp. Sens. 1; Skin Sens. 1; Carc. 2 (Inhl); STOT RE 2 (Lung / Inhl) **WHMIS 2015:** Eye Irrit. 2; Resp. Sens. 1; Skin Sens. 1; Carc. 2 (Inhl); STOT RE 2 (Lung / Inhl)	NDA
Chromium	**CAS:**7440-47-3 **EC Number:**231-157-5	0% TO 0.5%	NDA	**EU CLP:** Not Classified **UN GHS Revision 3:** Not Classified **OSHA HCS 2012:** Comb. Dust **WHMIS 2015:** Comb. Dust	NDA

See Section 16 for full text of H-statements.

Section 4 - First Aid Measures

4.1 Description of first aid measures

Inhalation
- Move victim to fresh air. Give artificial respiration if victim is not breathing. Administer oxygen if breathing is difficult. If signs/symptoms continue, get medical attention.

Skin
- Wash skin with soap and water. If skin irritation occurs: Get medical advice/attention.

Eye
- In case of contact with substance, immediately flush eyes with running water for at least 20 minutes. If eye irritation persists: Get medical advice/attention.

Ingestion
- Rinse mouth. Do not give anything by mouth to an unconscious person. Get medical attention if symptoms occur.

4.2 Most important symptoms and effects, both acute and delayed

- Refer to Section 11 - Toxicological Information.

4.3 Indication of any immediate medical attention and special treatment needed

Notes to Physician
- All treatments should be based on observed signs and symptoms of distress in the patient. Consideration should be given to the possibility that overexposure to materials other than this product may have occurred.

Section 5 - Firefighting Measures

5.1 Extinguishing media

Suitable Extinguishing Media
- Use dry powder extinguishing agent.

Unsuitable Extinguishing Media
- No data available

5.2 Special hazards arising from the substance or mixture

Unusual Fire and Explosion Hazards
- Metal powder dispersed in air may cause fire and explosion.
  Avoid generating dust; fine dust dispersed in air in sufficient concentrations, and in the presence of an ignition source is a potential dust explosion hazard.
  Molten metal can ignite combustibles.
  Molten metal will react violently with water.

Hazardous Combustion Products
- No data available

5.3 Advice for firefighters

- Wear positive pressure self-contained breathing apparatus (SCBA).
  Structural firefighters' protective clothing will only provide limited protection.

Section 6 - Accidental Release Measures

6.1 Personal precautions, protective equipment and emergency procedures

Personal Precautions

- Ventilate enclosed areas. Do not walk through spilled material. Wear appropriate personal protective equipment, avoid direct contact. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing.

Emergency Procedures

- ELIMINATE all ignition sources (no smoking, flares, sparks or flames in immediate area). As an immediate precautionary measure, isolate spill or leak area for at least 25 meters (75 feet) in all directions. If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (1/2 mile) in all directions; also, consider initial evacuation for 800 meters (1/2 mile) in all directions. Keep unauthorized personnel away.

6.2 Environmental precautions

- Avoid run off to waterways and sewers.

6.3 Methods and material for containment and cleaning up

Containment/Clean-up Measures

- Avoid generating dust.
  Solid ingot material should be picked up and recycled.
  Where possible allow molten material to solidify naturally.
  Residue from cutting or grinding should be swept or vacuumed and placed in suitable containers.
  Use clean nonsparking tools to collect material.
  Dust deposits should not be allowed to accumulate on surfaces, as these may form an explosive mixture if they are released into the atmosphere in sufficient concentration. Avoid dispersal of dust in the air (i.e., clearing dust surfaces with compressed air).

6.4 Reference to other sections

- Refer to Section 8 - Exposure Controls/Personal Protection and Section 13 - Disposal Considerations.

Section 7 - Handling and Storage

7.1 Precautions for safe handling

Handling

- Under normal conditions, exposure to cast ingots presents few health hazards in itself. Thermal cutting and melting of ingots may produce fumes and dust containing the component elements which may present potentially significant health hazards. Nickel can react with carbon monoxide in reducing atmospheres to form nickel carbonyl, an extremely toxic gas. Use only with adequate ventilation. Minimize dust generation and accumulation. Routine housekeeping should be instituted to ensure that dusts do not accumulate on surfaces. Dry powders can build static electricity charges when subjected to the friction of transfer and mixing operations. Provide adequate precautions, such as electrical grounding and bonding, or inert atmospheres. Cobalt causes a dermatitis of the allergic sensitivity type at points in friction. Cobalt toxicity also results in a progressive diffuse, interstitial pneumonia with a non-productive cough, dyspnea on exertion, interstitial fibrosis and cell damage. Other workers have experienced a sensitized respiratory disease characterized by cough, wheezing and shortness of breath where upon removal from the environment, the symptoms subside. Wear appropriate personal protective equipment, avoid direct contact. Do not breathe dust or fumes. Avoid contact with skin, eyes, and clothing. Wash thoroughly with soap and water after handling and before eating, drinking, or using tobacco.

7.2 Conditions for safe storage, including any incompatibilities

Storage

- Keep away from incompatible materials.

7.3 Specific end use(s)

- Refer to Section 1.2 - Relevant identified uses.

Section 8 - Exposure Controls/Personal Protection

8.1 Control parameters

Exposure Limits/Guidelines						
	Result	**ACGIH**	**Europe**	**NIOSH**	**OSHA**	**United Kingdom**
Chromium (7440-47-3)	TWAs	0.5 mg/m3 TWA	2 mg/m3 TWA	0.5 mg/m3 TWA	1 mg/m3 TWA	0.5 mg/m3 TWA
	STELs	Not established	Not established	Not established	Not established	1.5 mg/m3 STEL (calculated)
Manganese	STELs	Not established	Not established	3 mg/m3 STEL	Not established	1.5 mg/m3 STEL (calculated)
	TWAs	0.02 mg/m3 TWA (respirable fraction); 0.1 mg/m3 TWA (inhalable fraction)	Not established	1 mg/m3 TWA (fume)	Not established	0.5 mg/m3 TWA (as Mn)
	Ceilings	Not established	Not established	Not established	5 mg/m3 Ceiling (fume)	Not established
Cobalt (powder) (7440-48-4)	STELs	Not established	Not established	Not established	Not established	0.3 mg/m3 STEL (calculated)
	TWAs	0.02 mg/m3 TWA	Not established	0.05 mg/m3 TWA (dust and fume)	0.1 mg/m3 TWA (dust and fume)	0.1 mg/m3 TWA
Aluminum (7429-90-5)	STELs	Not established	Not established	Not established	Not established	30 mg/m3 STEL (calculated, inhalable dust); 12 mg/m3 STEL (calculated, respirable dust)
	TWAs	1 mg/m3 TWA (respirable fraction)	Not established	10 mg/m3 TWA (total dust); 5 mg/m3 TWA (respirable dust)	15 mg/m3 TWA (total dust); 5 mg/m3 TWA (respirable fraction)	10 mg/m3 TWA (inhalable dust); 4 mg/m3 TWA (respirable dust)
Silicon (7440-21-3)	STELs	Not established	Not established	Not established	Not established	30 ppm STEL (calculated, inhalable dust); 12 mg/m3 STEL (calculated, respirable dust)
	TWAs	Not established	Not established	10 mg/m3 TWA (total dust); 5 mg/m3 TWA (respirable dust)	15 mg/m3 TWA (total dust); 5 mg/m3 TWA (respirable fraction)	10 mg/m3 TWA (inhalable dust); 4 mg/m3 TWA (respirable dust)
Copper (7440-50-8)	STELs	Not established	Not established	Not established	Not established	0.6 mg/m3 STEL (calculated, fume); 2 mg/m3 STEL (dust and mist)
	TWAs	0.2 mg/m3 TWA (fume)	Not established	1 mg/m3 TWA (dust and mist); 0.1 mg/m3 TWA (fume)	0.1 mg/m3 TWA (fume); 1 mg/m3 TWA (dust and mist)	1 mg/m3 TWA (dust and mists); 0.2 mg/m3 TWA (fume)
Nickel (7440-02-0)	STELs	Not established	Not established	Not established	Not established	1.5 mg/m3 STEL (calculated)
	TWAs	1.5 mg/m3 TWA (inhalable fraction)	Not established	0.015 mg/m3 TWA	1 mg/m3 TWA	0.5 mg/m3 TWA

8.2 Exposure controls

Engineering

- Use a local exhaust when cutting, grinding, welding, or melting. It is recommended

Measures/Controls that dust control equipment such as local exhaust ventilation and material transport systems involved in handling of this product contain explosion relief vents or an explosion supression system or an oxygen-deficient environment. Ensure that dust handling systems (such as exhaust ducts, dust collectors, vessels and processing equipment) are designed in a manner to prevent the escape of dust into the work area (i.e., there is not leakage from the equipment). Use only appropriately classified electrical equipment.

Personal Protective Equipment

Respiratory
- For limited exposure, use P95 or N95 respirator. For prolonged exposure use an air-purifying respirator with high efficiency particulate air (HEPA) filters. Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or symptoms are experienced.

Eye/Face
- Wear safety goggles.

Skin/Body
- Wear appropriate gloves. Wear long sleeves and/or protective coveralls.

Environmental Exposure Controls
- Follow best practice for site management and disposal of waste.

Key to abbreviations

ACGIH = American Conference of Governmental Industrial Hygiene
NIOSH = National Institute of Occupational Safety and Health
OSHA = Occupational Safety and Health Administration
STEL = Short Term Exposure Limits are based on 15-minute exposures
TWA = Time-Weighted Averages are based on 8h/day, 40h/week exposures

Section 9 - Physical and Chemical Properties

9.1 Information on Basic Physical and Chemical Properties

Material Description			
Physical Form	Solid	Appearance/Description	A metallic gray metal ingot with no odor.
Color	Metallic gray.	Odor	Odorless
Odor Threshold	Data lacking		
General Properties			
Boiling Point	Data lacking	Melting Point/Freezing Point	2700 °F(1482.2222 °C)
Decomposition Temperature	Data lacking	pH	Data lacking
Specific Gravity/Relative Density	= 8 Water=1	Water Solubility	Negligible < 0.1 %
Viscosity	Data lacking	Explosive Properties	Data lacking
Oxidizing Properties:	Data lacking		
Volatility			
Vapor Pressure	Data lacking	Vapor Density	Data lacking
Evaporation Rate	Data lacking	Volatiles (Wt.)	0 %
Volatiles (Vol.)	0 %		
Flammability			
Flash Point	Data lacking	UEL	Data lacking
LEL	Data lacking	Autoignition	Data lacking
Flammability (solid, gas)	Data lacking		
Environmental			
Octanol/Water Partition coefficient	Data lacking		

9.2 Other Information

- No additional physical and chemical parameters noted.

Section 10: Stability and Reactivity

10.1 Reactivity

- No dangerous reaction known under conditions of normal use.

10.2 Chemical stability

- Stable under normal temperatures and pressures.

10.3 Possibility of hazardous reactions

- Hazardous polymerization will not occur.

10.4 Conditions to avoid

- Avoid generating dust.

10.5 Incompatible materials

- Cast Ingot is stable at ordinary temperature, however, caution should be taken with acids, bases, and oxidizers. Molten metal will react violently with water.

10.6 Hazardous decomposition products

- Under normal conditions, exposure to cast ingots presents few health hazards in itself. Thermal cutting and melting of ingots may produce fumes containing the component elements and breathing those fumes may present potentially significant health hazards.

Section 11 - Toxicological Information

11.1 Information on toxicological effects

Components		
Nickel (25% TO 70%)	7440-02-0	**Acute Toxicity:** Ingestion/Oral-Rat TDLo • 200 mg/kg; *Nutritional and Gross Metabolic:Gross Metabolite Changes*:**Weight loss or decreased weight gain**; *Behavioral*:**Somnolence (general depressed activity)**; **Multi-dose Toxicity:** Ingestion/Oral-Rat TDLo • 500 mg/kg 5 Day(s)-Intermittent; *Lungs, Thorax, or Respiration*:**Fibrosis, focal (pneumoconiosis)**; *Related to Chronic Data*:**Death in the Other Multiple Dose data type field**; Inhalation-Rabbit TCLo • 1 mg/m³ 6 Hour(s) 13 Week(s)-Intermittent; *Lungs, Thorax, or Respiration*:**Other changes**; *Lungs, Thorax, or Respiration*:**Changes in lung weight**; *Blood*:**Hemorrhage**; Inhalation-Rat TCLo • 0.4 mg/m³ 40 Week(s)-Intermittent; *Vascular*:**Thrombosis distant from injection site**; *Lungs, Thorax, or Respiration*:**Other changes**; *Related to Chronic Data*:**Death in the Other Multiple Dose data type field**; **Reproductive:** Ingestion/Oral-Rat TDLo • 158 mg/kg (multigenerations); *Reproductive Effects:Effects on Embryo or Fetus*:**Fetotoxicity (except death, e.g., stunted fetus)**; *Reproductive Effects:Effects on Embryo or Fetus*:**Fetal death**; **Tumorigen / Carcinogen:** Inhalation-Guinea Pig TCLo • 15 mg/m³ 91 Week(s)-Intermittent; *Tumorigenic*:**Equivocal tumorigenic agent by RTECS criteria**; *Lungs, Thorax, or Respiration*:**Tumors**; *Lungs, Thorax, or Respiration*:**Bronchiogenic carcinoma**
Manganese (0% TO 2%)	7439-96-5	**Acute Toxicity:** Ingestion/Oral-Rat LD50 • 9 g/kg; Inhalation-Man TCLo • 2300 µg/m³; *Brain and Coverings*:**Other degenerative changes**; *Behavioral*:**Changes in motor activity (specific assay)**; *Behavioral*:**Muscle weakness**; **Irritation:** Eye-Rabbit • 500 mg 24 Hour(s) • Mild irritation; Skin-Rabbit • 500 mg 24 Hour(s) • Mild irritation; **Multi-dose Toxicity:** Inhalation-Rat TCLo • 0.7 mg/m³ 24 Hour(s) 22 Week(s)-Continuous; *Lungs, Thorax, or Respiration*:**Fibrosis (interstitial)**; *Immunological Including Allergic*:**Decrease in cellular immune response**; Inhalation-Rat TCLo • 0.3 mg/m³ 5 Hour(s) 26 Week(s)-Intermittent; *Lungs, Thorax, or Respiration*:**Fibrosis (interstitial)**; *Immunological Including Allergic*:**Decrease in cellular immune response**; **Reproductive:** Ingestion/Oral-Mouse TDLo • 322.5 mg/kg (43D male); *Reproductive Effects:Paternal Effects*:**Spermatogenesis**; Ingestion/Oral-Rat TDLo • 50 mg/kg (20D post); *Reproductive Effects:Specific Developmental Abnormalities*:**Central nervous system**; *Reproductive Effects:Effects on Newborn*:**Biochemical and metabolic**; *Reproductive Effects:Effects on Newborn*:**Behavioral**; Ingestion/Oral-Rat TDLo • 90 mg/kg (18D post); *Reproductive Effects:Effects on Newborn*:**Growth statistics (e.g., reduced weight gain)**; *Reproductive Effects:Effects on Newborn*:**Biochemical and metabolic**; *Reproductive Effects:Effects on Newborn*:**Other postnatal measures or effects**
		Multi-dose Toxicity: Inhalation-Man TCLo • 4 mg/m³ 1 Year(s)-Intermittent; *Lungs, Thorax, or Respiration*:**Cough**; *Lungs,*

Aluminum (0% TO 5%)	7429-90-5	*Thorax, or Respiration*:**Dyspnea**; *Nutritional and Gross Metabolic:Gross Metabolite Changes*:**Weight loss or decreased weight gain**; Inhalation-Rat TCLo • 206 mg/m³ 5 Hour(s) 30 Day(s)-Intermittent; *Lungs, Thorax, or Respiration*:**Fibrosis (interstitial)**; *Endocrine*:**Hypoglycemia**; *Blood*:**Changes in serum composition (e.g., TP, bilirubin cholesterol)**
Silicon (0% TO 8%)	7440-21-3	**Acute Toxicity:** Ingestion/Oral-Rat LD50 • 3160 mg/kg; **Irritation:** Eye-Rabbit • 3 mg • Mild irritation
Cobalt (powder) (0% TO 2%)	7440-48-4	**Acute Toxicity:** Ingestion/Oral-Rat LD50 • 6171 mg/kg; *Behavioral*:**Somnolence (general depressed activity)**; *Behavioral*:**Ataxia**; *Gastrointestinal*:**Hypermotility, diarrhea**; **Multi-dose Toxicity:** Inhalation-Rabbit TCLo • 10 mg/m³ 2 Hour(s) 56 Day(s)-Intermittent; *Behavioral*:**Food intake (animal)**; *Lungs, Thorax, or Respiration*:**Emphysema**; *Liver*:**Fatty liver degeneration**; Inhalation-Rat TCLo • 0.09 mg/m³ 24 Hour(s) 4 Week(s)-Continuous; *Peripheral Nerve and Sensation*:**Recording from afferent nerve**; Inhalation-Rat TCLo • 2 mg/m³ 4 Day(s)-Intermittent; *Lungs, Thorax, or Respiration*:**Fibrosing alveolitis**
Copper (20% TO 70%)	7440-50-8	**Acute Toxicity:** Ingestion/Oral-Mouse TDLo • 108 mg/kg; *Behavioral*:**Tremor**; *Gastrointestinal*:**Hypermotility, diarrhea**; *Gastrointestinal*:**Nausea or vomiting**; Ingestion/Oral-Mouse TDLo • 158 mg/kg; *Kidney, Ureter, and Bladder*:**Changes in tubules (including acute renal failure, acute tubular necrosis)**; Ingestion/Oral-Mouse TDLo • 232 mg/kg; *Kidney, Ureter, and Bladder*:**Changes primarily in glomeruli**; *Blood*:**Changes in spleen**; *Blood*:**Changes in serum composition (e.g., TP, bilirubin cholesterol)**; **Multi-dose Toxicity:** Ingestion/Oral-Rabbit TDLo • 3 g/kg 60 Day(s)-Continuous; *Cardiac*:**Other changes**; *Liver*:**Hepatitis (hepatocellular necrosis), zonal**; *Related to Chronic Data*:**Death in the Other Multiple Dose data type field**; **Reproductive:** Ingestion/Oral-Rat TDLo • 1520 µg/kg (22W pre); *Reproductive Effects:Specific Developmental Abnormalities*:**Musculoskeletal system**; Ingestion/Oral-Rat TDLo • 152 mg/kg (22W pre); *Reproductive Effects:Effects on Embryo or Fetus*:**Fetotoxicity (except death, e.g., stunted fetus)**; *Reproductive Effects:Specific Developmental Abnormalities*:**Central nervous system**; Ingestion/Oral-Rat TDLo • 1210 µg/kg (35W pre); *Reproductive Effects:Effects on Fertility*:**Pre-implantation mortality**; *Reproductive Effects:Effects on Fertility*:**Post-implantation mortality**; **Tumorigen / Carcinogen:** Ingestion/Oral-Mouse TDLo • 10.08 mg/kg 12 Week(s)-Continuous; *Tumorigenic*:**Carcinogenic by RTECS criteria**; *Lungs, Thorax, or Respiration*:**Other changes**
Iron (0% TO 5%)	7439-89-6	**Acute Toxicity:** Ingestion/Oral-Rat LD50 • 750 mg/kg; *Blood*:**Changes in serum composition (e.g., TP, bilirubin cholesterol)**; *Biochemical:Enzyme inhibition, induction, or change in blood or tissue levels*:**Transaminases**; Ingestion/Oral-Child TDLo • 77 mg/kg; *Behavioral*:**Irritability**; *Gastrointestinal*:**Nausea or vomiting**; *Blood*:**Normocytic anemia**; **Multi-dose Toxicity:** Ingestion/Oral-Rat TDLo • 105 mg/kg 5 Week(s)-Continuous; *Liver*:**Tumors**; *Tumorigenic*:**Active as anti-cancer agent**; *Tumorigenic*:**Protects against induction of experimental tumors**

GHS Properties	Classification
Acute toxicity	**EU/CLP** • Data lacking **UN GHS 3** • Data lacking **OSHA HCS 2012** • Data lacking **WHMIS 2015** • Data lacking
Skin corrosion/Irritation	**EU/CLP** • Data lacking **UN GHS 3** • Data lacking **OSHA HCS 2012** • Data lacking **WHMIS 2015** • Data lacking
Serious eye damage/Irritation	**EU/CLP** • Data lacking **UN GHS 3** • Data lacking **OSHA HCS 2012** • Data lacking **WHMIS 2015** • Data lacking
Skin sensitization	**EU/CLP** • Skin Sensitizer 1 **UN GHS 3** • Skin Sensitizer 1 **OSHA HCS 2012** • Skin Sensitizer 1 **WHMIS 2015** • Skin Sensitizer 1
	EU/CLP • Respiratory Sensitizer 1

Respiratory sensitization	**UN GHS 3** • Respiratory Sensitizer 1 **OSHA HCS 2012** • Respiratory Sensitizer 1 **WHMIS 2015** • Respiratory Sensitizer 1
Aspiration Hazard	**EU/CLP** • Data lacking **UN GHS 3** • Data lacking **OSHA HCS 2012** • Data lacking **WHMIS 2015** • Data lacking
Carcinogenicity	**EU/CLP** • Carcinogenicity 2; Suspected of causing cancer **UN GHS 3** • Carcinogenicity 2 **OSHA HCS 2012** • Carcinogenicity 2 **WHMIS 2015** • Carcinogenicity 2
Germ Cell Mutagenicity	**EU/CLP** • Data lacking **UN GHS 3** • Data lacking **OSHA HCS 2012** • Data lacking **WHMIS 2015** • Data lacking
Toxicity for Reproduction	**EU/CLP** • Toxic to Reproduction 1B **UN GHS 3** • Toxic to Reproduction 1B **OSHA HCS 2012** • Toxic to Reproduction 1B **WHMIS 2015** • Toxic to Reproduction 1B
STOT-SE	**EU/CLP** • Specific Target Organ Toxicity Single Exposure 1; Specific Target Organ Toxicity Single Exposure 3: Respiratory Tract Irritation **UN GHS 3** • Specific Target Organ Toxicity Single Exposure 1; Specific Target Organ Toxicity Single Exposure 3: Respiratory Tract Irritation **OSHA HCS 2012** • Specific Target Organ Toxicity Single Exposure 1; Specific Target Organ Toxicity Single Exposure 3: Respiratory Tract Irritation **WHMIS 2015** • Specific Target Organ Toxicity Single Exposure 1; Specific Target Organ Toxicity Single Exposure 3: Respiratory Tract Irritation
STOT-RE	**EU/CLP** • Specific Target Organ Toxicity Repeated Exposure 1; Specific Target Organ Toxicity Repeated Exposure 2 **UN GHS 3** • Specific Target Organ Toxicity Repeated Exposure 1; Specific Target Organ Toxicity Repeated Exposure 2 **OSHA HCS 2012** • Specific Target Organ Toxicity Repeated Exposure 1; Specific Target Organ Toxicity Repeated Exposure 2 **WHMIS 2015** • Specific Target Organ Toxicity Repeated Exposure 1; Specific Target Organ Toxicity Repeated Exposure 2

Potential Health Effects

Inhalation

Acute (Immediate)

- May cause respiratory irritation. Processes such as cutting, grinding, crushing, or impact may result in generation of excessive amounts of airborne dusts in the workplace. Nuisance dust may affect the lungs but reactions are typically reversible. Cobalt toxicity also results in a progressive diffuse, interstitial pneumonia with a non-productive cough, dyspnea on exertion, interstitial fibrosis and cell damage. Other workers have experienced a sensitized respiratory disease characterized by cough, wheezing and shortness of breath where upon removal from the environment, the symptoms subside.

Chronic (Delayed)

- Chronic exposure to Nickel can cause effects such as rhinitis, sinusitis, nasal septal perforations and asthma have been reported in nickel refinery and nickel plating workers.

Skin

Acute (Immediate)

- Exposure to dust may cause mechanical irritation. Cobalt causes a dermatitis of the allergic sensitivity type at points in friction. Contact allergy to nickel is very common in human beings.

Chronic (Delayed)

- No data available.

Eye

Acute (Immediate)
- Exposure to dust may cause mechanical irritation. Excessive concentrations of nuisance dust in the workplace may reduce visibility and may cause unpleasant deposits in eyes.

Chronic (Delayed)
- No data available.

Ingestion

Acute (Immediate)
- Excessive concentrations of nuisance dust in the workplace may cause mechanical irritation to mucous membranes. Ingestion of large amounts of copper may cause damage to the kidneys.

Chronic (Delayed)
- Repeated and prolonged exposure to copper may affect the liver.

Other

Chronic (Delayed)
- Chronic exposure to Manganese dust and fumes can cause Manganism (Parkinson like disease).

Carcinogenic Effects
- Repeated and prolonged exposure to fumes and dust created in processing this product may cause cancer.

Carcinogenic Effects			
	CAS	IARC	NTP
Cobalt (powder)	7440-48-4	Group 2B-Possible Carcinogen	Not Listed
Nickel	7440-02-0	Group 2B-Possible Carcinogen	Reasonably Anticipated to be Human Carcinogen

Reproductive Effects
- Repeated and prolonged exposure to fumes and dust created in processing this product may cause reproductive effects.

Key to abbreviations

LD = Lethal Dose

TC = Toxic Concentration

TD = Toxic Dose

Section 12 - Ecological Information

12.1 Toxicity

Components		
Nickel (25% TO 70%)	7440-02-0	**Aquatic Toxicity-Fish:** 96 Hour(s) LC50 *Oncorhynchus mykiss (Rainbow Trout)* 0.06 mg/L 28 Day(s) NOEC *Cyprinus carpio (Common Carp)* 0.0035 µg/L **Aquatic Toxicity-Crustacea:** 7 Day(s) NOEC *Americamysis bahia (Opossum Shrimp)* 0.213 mg/L **Aquatic Toxicity-Algae and Other Aquatic Plant(s):** 96 Hour(s) EC50 *Pseudokirchneriella subcapitata (Green Algae)* 0.233 mg/L
Cobalt (powder) (0% TO 2%)	7440-48-4	**Aquatic Toxicity-Fish:** 96 Hour(s) LC50 *Pimephales promelas (Fathead Minnow)* 3.4 mg/L **Aquatic Toxicity-Crustacea:** 48 Hour(s) LC50 *Daphnia magna (Water Flea)* 4.4 mg/L 28 Day(s) NOEC *Daphnia magna (Water Flea)* 0.0028 mg/L
Copper (20% TO 70%)	7440-50-8	**Aquatic Toxicity-Fish:** 96 Hour(s) LC50 *Osteichthyes (Bony Fishes)* 0.0051 mg/L 7 Day(s) NOEC *Salmo trutta (Brown Trout)* 0.0075 mg/L **Aquatic Toxicity-Crustacea:** 21 Day(s) NOEC *Daphnia magna (Water Flea)* 0.002 mg/L 48 Hour(s) EC50 *Ceriodaphnia dubia (Water Flea)* 0.001 mg/L **Aquatic Toxicity-Algae and Other Aquatic Plant(s):** 48 Hour(s) EC50 *Chlorella sp. (Green Algae)* 0.0011 mg/L 7 Day(s) NOEC *Laminaria saccharina (Tangleweed, Brown Algae)* 0.01 mg/L
Iron (0% TO 5%)	7439-89-6	**Aquatic Toxicity-Fish:** 96 Hour(s) LC50 *Mudskipper(Periophthalmus waltoni)* 0.00648 mg/L 7 Day(s) NOEC *Brown Trout (Salmo trutta)* 0.305 mg/L **Aquatic Toxicity-Crustacea:** 7 Day(s) NOEC *Aquatic Sowbug, Isopod (Idotea balthica)* 0.5 mg/L

- The product is not expected to present an environmental hazard.

12.2 Persistence and degradability

- Material data lacking.

12.3 Bioaccumulative potential

- Material data lacking.

12.4 Mobility in Soil

- Material data lacking.

12.5 Results of PBT and vPvB assessment

- No PBT and vPvB assessment has been conducted.

12.6 Other adverse effects

- No studies have been found.

Section 13 - Disposal Considerations

13.1 Waste treatment methods

Product waste
- Dispose of content and/or container in accordance with local, regional, national, and/or international regulations.

Packaging waste
- Dispose of content and/or container in accordance with local, regional, national, and/or international regulations.

Section 14 - Transport Information

	14.1 UN number	14.2 UN proper shipping name	14.3 Transport hazard class(es)	14.4 Packing group	14.5 Environmental hazards
DOT	Not Applicable	Not Regulated	Not Applicable	Not Applicable	NDA
TDG	Not Applicable	Not Regulated	Not Applicable	Not Applicable	NDA
IMO/IMDG	Not Applicable	Not Regulated	Not Applicable	Not Applicable	NDA
IATA/ICAO	Not Applicable	Not Regulated	Not Applicable	Not Applicable	NDA

14.6 Special precautions for user
- None specified.

14.7 Transport in bulk according to Annex II of Marpol and the IBC Code
- Data lacking.

Section 15 - Regulatory Information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

SARA Hazard Classifications
- Acute, Chronic, Pressure(Sudden Release of)

Inventory						
Component	**CAS**	**Canada DSL**	**Canada NDSL**	**EU EINECS**	**EU ELNICS**	**TSCA**
Aluminum	7429-90-5	Yes	No	Yes	No	Yes
Chromium	7440-47-3	Yes	No	Yes	No	Yes
Cobalt (powder)	7440-48-4	Yes	No	Yes	No	Yes
Copper	7440-50-8	Yes	No	Yes	No	Yes
Iron	7439-89-6	Yes	No	Yes	No	Yes

Manganese	7439-96-5	Yes	No	Yes	No	Yes
Nickel	7440-02-0	Yes	No	Yes	No	Yes
Silicon	7440-21-3	Yes	No	Yes	No	Yes

Canada

Labor

Canada - WHMIS 1988 - Classifications of Substances

• Copper	7440-50-8	Uncontrolled product according to WHMIS classification criteria
• Chromium	7440-47-3	Uncontrolled product according to WHMIS classification criteria
• Manganese	7439-96-5	D2A; B4, D2A (powder)
• Cobalt (powder)	7440-48-4	D2A, D2B
• Aluminum	7429-90-5	B6 (powder); Uncontrolled product according to WHMIS classification criteria
• Nickel	7440-02-0	D2A, D2B; B6, D2A (Raney)
• Silicon	7440-21-3	B4
• Iron	7439-89-6	Uncontrolled product according to WHMIS classification criteria

Canada - WHMIS 1988 - Ingredient Disclosure List

• Copper	7440-50-8	1 %
• Chromium	7440-47-3	0.1 %
• Manganese	7439-96-5	1 %
• Cobalt (powder)	7440-48-4	0.1 %
• Aluminum	7429-90-5	1 %
• Nickel	7440-02-0	0.1 %
• Silicon	7440-21-3	Not Listed
• Iron	7439-89-6	Not Listed

Environment

Canada - CEPA - Priority Substances List

• Copper	7440-50-8	Not Listed
• Chromium	7440-47-3	Not Listed
• Manganese	7439-96-5	Not Listed
• Cobalt (powder)	7440-48-4	Not Listed
• Aluminum	7429-90-5	Not Listed
• Nickel	7440-02-0	Not Listed
• Silicon	7440-21-3	Not Listed
• Iron	7439-89-6	Not Listed

United States

Labor

U.S. - OSHA - Process Safety Management - Highly Hazardous Chemicals

• Copper	7440-50-8	Not Listed
• Chromium	7440-47-3	Not Listed
• Manganese	7439-96-5	Not Listed
• Cobalt (powder)	7440-48-4	Not Listed
• Aluminum	7429-90-5	Not Listed

• Nickel	7440-02-0	Not Listed
• Silicon	7440-21-3	Not Listed
• Iron	7439-89-6	Not Listed

U.S. - OSHA - Specifically Regulated Chemicals

• Copper	7440-50-8	Not Listed
• Chromium	7440-47-3	Not Listed
• Manganese	7439-96-5	Not Listed
• Cobalt (powder)	7440-48-4	Not Listed
• Aluminum	7429-90-5	Not Listed
• Nickel	7440-02-0	Not Listed
• Silicon	7440-21-3	Not Listed
• Iron	7439-89-6	Not Listed

Environment

U.S. - CAA (Clean Air Act) - 1990 Hazardous Air Pollutants

• Copper	7440-50-8	Not Listed
• Chromium	7440-47-3	Not Listed
• Manganese	7439-96-5	Not Listed
• Cobalt (powder)	7440-48-4	Not Listed
• Aluminum	7429-90-5	Not Listed
• Nickel	7440-02-0	Not Listed
• Silicon	7440-21-3	Not Listed
• Iron	7439-89-6	Not Listed

U.S. - CERCLA/SARA - Hazardous Substances and their Reportable Quantities

• Copper	7440-50-8	5000 lb final RQ (no reporting of releases of this hazardous substance is required if the diameter of the pieces of the solid metal released is >100 µm); 2270 kg final RQ (no reporting of releases of this hazardous substance is required if the diameter of the pieces of the solid metal released is >100 µm)
• Chromium	7440-47-3	5000 lb final RQ (no reporting of releases of this hazardous substance is required if the diameter of the pieces of the solid metal released is >100 µm); 2270 kg final RQ (no reporting of releases of this hazardous substance is required if the diameter of the pieces of the solid metal released is >100 µm)
• Manganese	7439-96-5	Not Listed
• Cobalt (powder)	7440-48-4	Not Listed
• Aluminum	7429-90-5	Not Listed
• Nickel	7440-02-0	100 lb final RQ (no reporting of releases of this hazardous substance is required if the diameter of the pieces of the solid metal released is >100 µm); 45.4 kg final RQ (no

		reporting of releases of this hazardous substance is required if the diameter of the pieces of the solid metal released is >100 µm)
• Silicon	7440-21-3	Not Listed
• Iron	7439-89-6	Not Listed

U.S. - CERCLA/SARA - Radionuclides and Their Reportable Quantities

• Copper	7440-50-8	Not Listed
• Chromium	7440-47-3	Not Listed
• Manganese	7439-96-5	Not Listed
• Cobalt (powder)	7440-48-4	Not Listed
• Aluminum	7429-90-5	Not Listed
• Nickel	7440-02-0	Not Listed
• Silicon	7440-21-3	Not Listed
• Iron	7439-89-6	Not Listed

U.S. - CERCLA/SARA - Section 302 Extremely Hazardous Substances EPCRA RQs

• Copper	7440-50-8	Not Listed
• Chromium	7440-47-3	Not Listed
• Manganese	7439-96-5	Not Listed
• Cobalt (powder)	7440-48-4	Not Listed
• Aluminum	7429-90-5	Not Listed
• Nickel	7440-02-0	Not Listed
• Silicon	7440-21-3	Not Listed
• Iron	7439-89-6	Not Listed

U.S. - CERCLA/SARA - Section 302 Extremely Hazardous Substances TPQs

• Copper	7440-50-8	Not Listed
• Chromium	7440-47-3	Not Listed
• Manganese	7439-96-5	Not Listed
• Cobalt (powder)	7440-48-4	Not Listed
• Aluminum	7429-90-5	Not Listed
• Nickel	7440-02-0	Not Listed
• Silicon	7440-21-3	Not Listed
• Iron	7439-89-6	Not Listed

U.S. - CERCLA/SARA - Section 313 - Emission Reporting

• Copper	7440-50-8	1.0 % de minimis concentration
• Chromium	7440-47-3	1.0 % de minimis concentration
• Manganese	7439-96-5	1.0 % de minimis concentration
• Cobalt (powder)	7440-48-4	0.1 % de minimis concentration
• Aluminum	7429-90-5	1.0 % de minimis concentration (dust or fume only)
• Nickel	7440-02-0	0.1 % de minimis concentration
• Silicon	7440-21-3	Not Listed
• Iron	7439-89-6	Not Listed

U.S. - CERCLA/SARA - Section 313 - PBT Chemical Listing

• Copper	7440-50-8	Not Listed
• Chromium	7440-47-3	Not Listed
• Manganese	7439-96-5	Not Listed
• Cobalt (powder)	7440-48-4	Not Listed
• Aluminum	7429-90-5	Not Listed
• Nickel	7440-02-0	Not Listed
• Silicon	7440-21-3	Not Listed
• Iron	7439-89-6	Not Listed

United States - California

Environment

U.S. - California - Proposition 65 - Carcinogens List

• Copper	7440-50-8	Not Listed
• Chromium	7440-47-3	Not Listed
• Manganese	7439-96-5	Not Listed
• Cobalt (powder)	7440-48-4	carcinogen, 7/1/1992 (powder)
• Aluminum	7429-90-5	Not Listed
• Nickel	7440-02-0	carcinogen, 10/1/1989 (metallic)
• Silicon	7440-21-3	Not Listed
• Iron	7439-89-6	Not Listed

U.S. - California - Proposition 65 - Developmental Toxicity

• Copper	7440-50-8	Not Listed
• Chromium	7440-47-3	Not Listed
• Manganese	7439-96-5	Not Listed
• Cobalt (powder)	7440-48-4	Not Listed
• Aluminum	7429-90-5	Not Listed
• Nickel	7440-02-0	Not Listed
• Silicon	7440-21-3	Not Listed
• Iron	7439-89-6	Not Listed

U.S. - California - Proposition 65 - Maximum Allowable Dose Levels (MADL)

• Copper	7440-50-8	Not Listed
• Chromium	7440-47-3	Not Listed
• Manganese	7439-96-5	Not Listed
• Cobalt (powder)	7440-48-4	Not Listed
• Aluminum	7429-90-5	Not Listed
• Nickel	7440-02-0	Not Listed
• Silicon	7440-21-3	Not Listed
• Iron	7439-89-6	Not Listed

U.S. - California - Proposition 65 - No Significant Risk Levels (NSRL)

• Copper	7440-50-8	Not Listed
• Chromium	7440-47-3	Not Listed
• Manganese	7439-96-5	Not Listed
• Cobalt (powder)	7440-48-4	Not Listed
• Aluminum	7429-90-5	Not Listed
• Nickel	7440-02-0	Not Listed
• Silicon	7440-21-3	Not Listed
• Iron	7439-89-6	Not Listed

U.S. - California - Proposition 65 - Reproductive Toxicity - Female

• Copper	7440-50-8	Not Listed
• Chromium	7440-47-3	Not Listed
• Manganese	7439-96-5	Not Listed
• Cobalt (powder)	7440-48-4	Not Listed
• Aluminum	7429-90-5	Not Listed
• Nickel	7440-02-0	Not Listed
• Silicon	7440-21-3	Not Listed
• Iron	7439-89-6	Not Listed
U.S. - California - Proposition 65 - Reproductive Toxicity - Male		
• Copper	7440-50-8	Not Listed
• Chromium	7440-47-3	Not Listed
• Manganese	7439-96-5	Not Listed
• Cobalt (powder)	7440-48-4	Not Listed
• Aluminum	7429-90-5	Not Listed
• Nickel	7440-02-0	Not Listed
• Silicon	7440-21-3	Not Listed
• Iron	7439-89-6	Not Listed

15.2 Chemical Safety Assessment

- No Chemical Safety Assessment has been carried out.

15.3 Other Information

- WARNING: This product contains a chemical known to the State of California to cause cancer.

Section 16 - Other Information

Relevant Phrases (code & full text)

- H228 - Flammable solid
  H261 - In contact with water releases flammable gas
  H302 - Harmful if swallowed
  H319 - Causes serious eye irritation
  H361 - Suspected of damaging fertility or the unborn child.
  H400 - Very toxic to aquatic life
  H410 - Very toxic to aquatic life with long lasting effects
  H412 - Harmful to aquatic life with long lasting effects
  H413 - May cause long lasting harmful effects to aquatic life

Revision Date
- 08/March/2018

Preparation Date
- 13/June/2011

Other Information
- To access SDS online, go to Doncasters.com/EHS/SDS.

Disclaimer/Statement of Liability
- The information herein is given in good faith but no warranty, expressed or implied, is made.

Key to abbreviations

NDA = No Data Available

SDS no. MI11298
Version 2
Revision date 03/Feb/2015
Supersedes date 21/Jul/2010

Safety Data Sheet
PLATINUM D-D†

Quantity restrictions apply! Not to be used in quantities of 1 tonne or more within the EEA.

1. Identification of the substance/preparation and of the Company/undertaking

1.1 Product identifier

Product name PLATINUM D-D†
Product code MI11298

1.2 Relevant identified uses of the substance or mixture and uses advised against

Recommended Use Wetting agent

Uses advised against Consumer use

1.3 Details of the supplier of the safety data sheet

Supplier
M-I Australia Pty Ltd
Level 5
256 St. George Terrace
Perth
WA 6000
T= 08 9440 2900
MISDS@slb.com

1.4 Emergency Telephone Number

Emergency telephone - (24 Hour) Australia +61 2801 44558, Asia Pacific +65 3158 1074, China +86 10 5100 3039, Europe +44 (0) 1235 239 670, Middle East and Africa +44 (0) 1235 239 671, New Zealand +64 9929 1483, USA 001 281 561 1600

2. Hazards identification

2.1 Classification of the substance or mixture

Classification according to (EC) No. 1272/2008

Health hazards

Skin corrosion/irritation	Category 2
Serious eye damage/eye irritation	Category 1

Environmental hazards Not classified

Physical Hazards Not classified

2.2 Label elements

Signal word
DANGER

Hazard statements
H315 - Causes skin irritation
H318 - Causes serious eye damage

Precautionary Statements - EU (§28, 1272/2008)
P264 - Wash face, hands and any exposed skin thoroughly after handling
P280 - Wear protective gloves/ protective clothing/ eye protection/ face protection
P305 + P351 + P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P310 - Immediately call a POISON CENTER or doctor/ physician
P302 + P352 - IF ON SKIN: Wash with plenty of soap and water
P501 - Dispose of contents/container in accordance with local regulations.

Supplementary precautionary statements
P332 + P313 - If skin irritation occurs: Get medical advice/ attention
P362 - Take off contaminated clothing and wash before reuse

Classification according to EU Directives 67/548/EEC or 1999/45/EC

Indication of danger
Xi - Irritant

R-code(s)
R38, R41

Contains

Water

Sodium dodecylbenzenesulfonate

Tetrapotassium diphosphate

Alcohols, C10-16, ethoxylated, sulfates, sodium salts

For the full text of the R-phrases and H-Statements mentioned in this Section, see Section 16.

2.3 Other data

Not classified as PBT/vPvB by current EU criteria

Australian statement of hazardous/dangerous nature
Classified as Hazardous according to the criteria of NOHSC.
HAZARDOUS SUBSTANCE. NON-DANGEROUS GOODS.

3. Composition/information on ingredients

3.1 Substances

Not Applicable

3.2 Mixtures

Component	EC-No.	CAS-No	Weight % - range	Classification (67/548)	Classification (Reg. 1272/2008)	REACH registration number
Water	244-063-4	7732-18-5	60-100	-	Not classified	No data available
Sodium dodecylbenzenesulfonate	246-680-4	25155-30-0	1-5	Xn; R22 Xi; R38, R41	Acute Tox. 4 (H302) Skin Irrit. 2 (H315) Eye Dam. 1 (H318)	No data available
Tetrapotassium diphosphate	230-785-7	7320-34-5	1-5	Xi; R36	Eye Irrit. 2 (H319)	No data available
Alcohols, C10-16, ethoxylated, sulfates, sodium salts	500-223-8	68585-34-2	1-5	Xi; R36/38	Skin Irrit. 2 (H315) Eye Irrit 2. (H319)	No data available

Comments
The product contains other ingredients which do not contribute to the overall classification.

4. First aid measures

4.1 First-Aid Measures

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

Ingestion Rinse mouth. Do not induce vomiting without medical advice. Never give anything by mouth to an unconscious person. Seek medical attention if irritation occurs.

Skin contact Wash off immediately with soap and plenty of water removing all contaminated clothes and shoes. Get medical attention immediately if symptoms occur.

Eye contact Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first five minutes, then continue rinsing eye. Seek medical attention at once.

4.2 Most important symptoms and effects, both acute and delayed

General advice The severity of the symptoms described will vary dependant of the concentration and the length of exposure. If adverse symptoms develop, the casualty should be transferred to hospital as soon as possible.

Main symptoms

Inhalation Please see Section 11. Toxicological Information for further information.

Ingestion Please see Section 11. Toxicological Information for further information.

Skin contact Please see Section 11. Toxicological Information for further information.

Eye contact Please see Section 11. Toxicological Information for further information.

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, Alcohol Foam, CO_2, Dry Chemical.

Extinguishing media which shall not be used for safety reasons
Water may be ineffective.

5.2 Special hazards arising from the substance or mixture

Unusual fire and explosion hazards
None known.

Hazardous combustion products
Fire or high temperatures create:, Carbon oxides (COx).

5.3 Advice for firefighters

Special protective equipment for fire-fighters
As in any fire, wear self-contained breathing apparatus and full protective gear.

Special Fire-Fighting Procedures
Containers close to fire should be removed immediately or cooled with water.

6. Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

Use personal protective equipment. See also section 8.

6.2 Environmental precautions

The product should not be allowed to enter drains, water courses or the soil.

Environmental exposure controls
Avoid release to the environment. Local authorities should be advised if significant spillages cannot be contained.

6.3 Methods and materials for containment and cleaning up

Methods for containment
Prevent further leakage or spillage if safe to do so. Dike far ahead of liquid spill for later disposal.

Methods for cleaning up
Absorb with earth, sand or other non-combustible material and transfer to containers for later disposal. After cleaning, flush away traces with water.

6.4 Reference to other sections

See section 13 for more information.

7. Handling and storage

7.1 Precautions for safe handling

Handling
Handle in accordance with good industrial hygiene and safety practice. Avoid contact with skin and eyes. Do not breathe vapors or spray mist. Avoid spills and splashing during use.

7.2 Conditions for safe storage, including any incompatibilities

Technical measures/precautions Ensure adequate ventilation.

Storage precautions Keep containers tightly closed in a dry, cool and well-ventilated place. Avoid: High temperatures. Avoid contact with: Strong oxidizing agents

Packaging material Use specially constructed containers only

7.3 Specific end uses

See Section 1.2.

8. Exposure controls/personal protection

8.1 Control parameters

Exposure limits Contains no substances with occupational exposure limit values
No biological limit allocated

Component	EU OEL	Austria	Australia	Denmark
Water	Not determined	Not determined	Not determined	Not determined
Sodium dodecylbenzenesulfonate	Not determined	Not determined	Not determined	Not determined
Tetrapotassium diphosphate	Not determined	Not determined	Not determined	Not determined
Alcohols, C10-16, ethoxylated, sulfates, sodium salts	Not determined	Not determined	Not determined	Not determined

Component	Finland	France	Germany	Hungary
Water	Not determined	Not determined	Not determined	Not determined
Sodium dodecylbenzenesulfonate	Not determined	Not determined	Not determined	Not determined
Tetrapotassium diphosphate	Not determined	Not determined	Not determined	Not determined
Alcohols, C10-16, ethoxylated, sulfates, sodium salts	Not determined	Not determined	Not determined	Not determined

Component	New Zealand	Italy	Netherlands	Norway
Water	Not Determined	Not determined	Not determined	Not determined
Sodium dodecylbenzenesulfonate	Not Determined	Not determined	Not determined	Not determined
Tetrapotassium diphosphate	Not Determined	Not determined	Not determined	Not determined
Alcohols, C10-16, ethoxylated, sulfates, sodium salts	Not Determined	Not determined	Not determined	Not determined

Component	Poland	Portugal	Romania	Russia
Water	Not determined	Not determined	Not determined	Not determined
Sodium dodecylbenzenesulfonate	Not determined	Not determined	Not determined	Not determined
Tetrapotassium diphosphate	Not determined	Not determined	Not determined	Not determined
Alcohols, C10-16, ethoxylated, sulfates, sodium salts	Not determined	Not determined	Not determined	Not determined

Component	Spain	Switzerland	Turkey	UK
Water	Not determined	Not determined	Not determined	Not determined
Sodium dodecylbenzenesulfonate	Not determined	Not determined	Not determined	Not determined
Tetrapotassium diphosphate	Not determined	Not determined	Not determined	Not determined
Alcohols, C10-16, ethoxylated, sulfates, sodium salts	Not determined	Not determined	Not determined	Not determined

8.2 Exposure controls

All chemical Personal Protective Equipment (PPE) should be selected based on an assessment of both the chemical hazard present and the risk of exposure to those hazards. The PPE recommendations below are based on an assessment of the chemical hazards associated with this product. Where this product is used in a mixture with other products or fluids, additional hazards may be created and as such further assessment of risk may be required. The risk of exposure and need of respiratory protection will vary from workplace to workplace and should be assessed by the user in each situation.

Engineering measures to reduce exposure
Ensure adequate ventilation. Mechanical ventilation or local exhaust ventilation is required.

Personal protective equipment

Eye protection	It is good practice to wear goggles when handling any chemical. Tightly fitting safety goggles.
Hand protection	Use protective gloves made of:, Nitrile, Neoprene, Be aware that liquid may penetrate the gloves. Frequent change is advisable.
Respiratory protection	In case of insufficient ventilation wear suitable respiratory equipment, Use respirator with organic vapor protection (A, brown), At work in confined or poorly ventilated spaces, respiratory protection with air supply must be used.
Skin and body protection	Wear suitable protective clothing, Eye wash and emergency shower must be available at the work place.

Hygiene measures Wash hands before eating, drinking or smoking, Remove and wash contaminated clothing before re-use.

9. Physical and chemical properties

9.1 Information on basic physical and chemical properties

Physical state	Liquid
Appearance	Viscous
Odor	Lemon
Color	Pink
Odor threshold	Not applicable

Property	Values	Remarks

pH	8 - 10	
pH @ dilution	7.5-8.5	@ 1%
Melting/freezing point		
Boiling point/range	100 °C / 212 °F	
Flash point	> 93 °C / > 200 °F	
Evaporation rate (BuAc =1)	< 1	
Flammability (solid, gas)	Not Applicable	
Flammability Limits in Air		
Upper flammability limit	Not applicable	
Lower flammability limit	Not applicable	
Vapor pressure	No information available	
Vapor density	No information available	
Specific gravity	No information available	
Bulk density	No information available	
Relative density	1.038 sg	@ 20°C.
Water solubility	Soluble in water	
Solubility in other solvents	No information available	
Autoignition temperature	No information available	
Decomposition temperature	No information available	
Kinematic viscosity		
Dynamic viscosity	145 cP	
Log Pow	No information available	

Explosive properties	No information available
Oxidizing properties	No information available

9.2 Other information

Pour point	No information available
Molecular weight	No information available
VOC content(%)	0.07
Density	No information available

10. Stability and reactivity

10.1 Reactivity

No specific reactivity hazards associated with this product.

10.2 Chemical stability

Stable under normal temperature conditions and recommended use.

10.3 Possibility of Hazardous Reactions

Hazardous polymerization
Hazardous polymerization does not occur.

10.4 Conditions to avoid

High temperatures.

10.5 Incompatible materials

Strong oxidizing agents.

10.6 Hazardous decomposition products

See also section 5.2.

11. Toxicological information

11.1 Information on toxicological effects

Acute toxicity

Inhalation Vapors may irritate throat and respiratory system.

Eye contact Causes serious eye damage.

Skin contact Causes skin irritation.

Ingestion Ingestion may cause stomach discomfort.

Unknown acute toxicity .

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Water	> 90 mL/kg (Rat)	No data available	No data available
Sodium dodecylbenzenesulfonate	= 438 mg/kg (Rat)	No data available	No data available
Tetrapotassium diphosphate	No data available	> 4640 mg/kg (Rabbit)	No data available
Alcohols, C10-16, ethoxylated, sulfates, sodium salts	No data available	No data available	No data available

Sensitization This product does not contain any components suspected to be sensitizing.

Mutagenic effects This product does not contain any known or suspected mutagens.

Carcinogenicity This product does not contain any known or suspected carcinogens.

Reproductive toxicity This product does not contain any known or suspected reproductive hazards.

Routes of exposure Eye contact. Skin contact.

Routes of entry Eye contact.

Specific target organ toxicity (single exposure) Not classified

Specific target organ toxicity (repeated exposure) Not classified.

Aspiration hazard No hazard from product as supplied.

12. Ecological information

12.1 Toxicity

The product component(s) are not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment.

Toxicity to algae
This product is not considered toxic to algae.

Toxicity to fish
This product is not considered toxic to fish.

Toxicity to daphnia and other aquatic invertebrates
This product is not considered toxic to invertebrates.

Component	Toxicity to fish	Toxicity to algae	Toxicity to daphnia and other aquatic invertebrates
Water	No information available	No information available	No information available
Sodium dodecylbenzenesulfonate	10.8 mg/L LC50 (Oncorhynchus mykiss) = 96 h	No information available	No information available
Tetrapotassium diphosphate	100 mg/L LC50 (Oncorhynchus mykiss) = 96 h	No information available	100 mg/L EC50 (water flea) = 48 h
Alcohols, C10-16, ethoxylated, sulfates, sodium salts	No information available	No information available	No information available

Percent unknown aquatic toxicity

12.2 Persistence and degradability

No product level data available.

12.3 Bioaccumulative potential

No product level data available.

12.4 Mobility in soil

Mobility
Soluble in water.

12.5 Results of PBT and vPvB assessment

Not classified as PBT/vPvB by current EU criteria.

12.6 Other adverse effects.

None known.

13. Disposal considerations

13.1 Waste treatment methods

Waste from residues / unused products	Dispose of in accordance with local regulations.
Contaminated packaging	Empty containers should be taken for local recycling, recovery or waste disposal.
EWC Waste disposal No.	According to the European Waste Catalogue, Waste Codes are not product specific, but application specific. Waste codes should be assigned by the user based on the application for which the product was used. The following Waste Codes are only suggestions: EWC waste disposal No: 07 01 04 Waste Code: 7152 Organic waste without halogen.

14. Transport information

The product is not covered by international regulation on the transport of dangerous goods (IMDG, IATA,ADR/RID/ADG).

14.1 UN Number
Not regulated

14.2 Proper shipping name
Not regulated

14.3 Hazard class(es)

ADR/RID/ADN Hazard class	Not regulated
IMDG Hazard class	Not regulated
ICAO Hazard class/division	Not regulated

14.4 Packing group

ADR/RID/ADN Packing Group	Not regulated
IMDG Packing group	Not regulated
ICAO Packing group	Not regulated

14.5 Environmental hazard
No

14.6 Special precautions
Not Applicable

14.7 Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code
Please contact MISDS@slb.com for info regarding transport in Bulk.

15. Regulatory information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

Germany, Water Endangering Classes (VwVwS)	Water endangering class = 2

Australian Standard for the Uniform Scheduling of Drugs and Poisons
No Poisons Schedule number allocated

Sodium dodecylbenzenesulfonate
Schedule 5

New Zealand hazard classification	Irritant

HSNO approval no.	HRS002503
Group number	6.3A, 8.3A

Commission Regulation (EU) No 453/2010 of 20 May 2010 amending Regulation (EC) No 1907/2006 of the European Parliament and of the Council on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH). Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC, including amendments.

This safety data sheet complies with the requirements of Regulation (EC) No. 1272/2008.

National Code of Practice for the Preparation of Material Safety Data Sheets 2nd Edition [NOHSC: 2011 (2003)].

National Occupational Health and Safety Commission's Approved Criteria for Classifying Hazardous Substances [NOHSC:1008 (2004) 3rd Edition].

National Occupational Health and Safety Commission's Exposure Standards for Atmospheric Contaminants in the occupational Environment [NOHSC:1003 (1995)].

Safe Work Australia.

Standard for the Uniform Scheduling of Drugs and Poisons (SUSDP).

Not classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for transport by road or rail.

International inventories

USA (TSCA)	Complies
European Union (EINECS and ELINCS)	Complies
Canada (DSL)	Complies
Philippines (PICCS)	Complies
Japan (ENCS)	Complies
China (IECSC)	Complies
Australia (AICS)	Complies
Korean (KECL)	Complies
New Zealand (NZIoC)	Complies

Restricted for use in Europe until REACH assessed. Please contact REACH@miswaco.slb.com if intended for use in Europe.

15.2 Chemical Safety Report

No information available

16. Other information

Prepared by	Global Regulatory Compliance - Chemicals (GRC - Chemicals) , Anne Karin (Anka) Fosse
Supersedes date	21/Jul/2010
Revision date	03/Feb/2015
Version	2
The following sections have been revised	This SDS has been made in a new database and therefore a new layout. There have been changes with regard to classification, Updated according to GHS/CLP.

Text of R phrases mentioned in Section 2 and 3
R22 - Harmful if swallowed
R36 - Irritating to eyes
R38 - Irritating to skin
R41 - Risk of serious damage to eyes

R36/38 - Irritating to eyes and skin

Full text of H-Statements referred to under sections 2 and 3

H315 - Causes skin irritation
H318 - Causes serious eye damage
H302 - Harmful if swallowed
H319 - Causes serious eye irritation

†A mark of M-I L.L.C.

Disclaimer
The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

SAFETY DATA SHEET

Sand Force

Section: 1. PRODUCT AND COMPANY IDENTIFICATION

Product name	:	Sand Force
Other means of identification	:	N/A
Recommended use	:	Viscosifier
Restrictions on use	:	None known
Company	:	Right Turn Supply LLC P.O. Box 132016 Spring, TX 77393
Emergency telephone number	:	(800) 424-9300 (24 Hours) CHEMTREC
Issuing date	:	08/01/2018

Section: 2. HAZARDS IDENTIFICATION

GHS Classification

Flammable liquids	:	Not classified
Skin irritation	:	Not classified
Eye irritation	:	Not classified
Carcinogenicity	:	Not classified
Reproductive toxicity	:	Not classified
Specific target organ toxicity - single exposure	:	Not classified
Aspiration hazard	:	Not classified

GHS Label element

Hazard pictograms :

Signal Word	:	Warning
Hazard Statements	:	May form combustible dust concentrations in air.

Precautionary Statements :

Prevention:
P201 – Obtain special instructions before use.
P264 – Wash face, hands and any exposed skin thoroughly after handling.
P280 – Wear protective gloves/protective clothing/eye protection/face protection.

Response:
P308 + P313 – If exposed or concerned: Get medical advice/attention.
P302 + P352 – IF ON SKIN: Wash with plenty of soap and water.
P332 + P313 – If skin irritation occurs: Get medical advice/attention.
P363 – Wash contaminated clothing before reuse.
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 attention/advice.

Storage:
P403 + P235: Store in a well-ventilated place. Keep cool
P404 – Store in a closed container
P405 – Store locked up.

Disposal:
P501 – Dispose of contents/container in accordance with local/regional/national regulations.

Other hazards : None Known

Section: 3. COMPOSITION/INFORMATION ON INGREDIENTS

Substances	CAS Number	Percent	GHS Classification – US
Xanthan Gum	11138-66-22	60 – 100%	Expl. Dust (Combustible Dust)

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

Section: 4. FIRST AID MEASURES

In case of eye contact : Flush eyes with water for at least 15 minutes, holding eyelids open. Remove Any contact lenses. If irritation persists, seek medical attention.

In case of skin contact : Wash with soap and water. Get medical attention if irritation persists.

If swallowed : Under normal conditions, first aid procedures are not required.

If inhaled	:	If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.
Protection of first-aiders	:	Move to fresh air. Call a physician if symptoms develop or persist.
Notes to physician	:	Treat symptomatically.
Most important symptoms and effects, both acute and delayed	:	No significant hazards expected.

Section: 5. FIREFIGHTING MEASURES

Suitable extinguishing media	:	Water, fog, carbon dioxide, foam, dry chemical.
Unsuitable extinguishing media	:	None known
Specific hazards during firefighting	:	Full protective clothing and approved self-contained breathing apparatus required for firefighting personnel.
Hazardous combustion products	:	Decomposition in fire may produce toxic gases. Organic dust in the presence of an ignition source can be explosive in high concentrations. Good housekeeping practices are required to minimize this potential
Special protective equipment for firefighters	:	Self-contained breathing apparatus and full protective clothing must be worn in case of fire.
Specific extinguishing methods	:	Use standard firefighting procedures and consider the hazards of other involved materials.

Section: 6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures	:	Avoid contact with skin, eyes and clothing. Ventilate area. Avoid creating and breathing dust. Wear appropriate personal protective equipment.
Environmental precautions	:	Prevent from entering sewers, waterways or low areas.
Methods and materials 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. In the event of spill or accidental release, notify relevant authorities in accordance with all applicable regulations. For waste disposal, see section 13 of the SDS.

Section: 7. HANDLING AND STORAGE

Advice on safe handling : Wear personal protective equipment. Avoid contact with eyes, skin or clothing. Wash hands after use. Do not eat, drink or smoke in work area. Wash contaminated clothing before reuse. Wear a NIOSH-approved, European Standard En 149, or equivalent when using this product. Material slippery when wet. Avoid creating or inhaling dust.

Conditions for safe storage : Store in a cool dry place. Keep away from oxidizers. Protect from physical damage.

Section: 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Components with workplace control parameters

8(a): OCCUPATIONAL EXPOSURE LIMITS:

Substances	CAS Number	OSHA PEL-TWA	ACGIH-TLV-TWA
Xanthan Gum	11138-66-2	15 mg/m³	10 mg/m³

Engineering measures : Use in a well-ventilated area. Use approved industrial ventilation and local exhaust. As required to maintain exposures below applicable exposure limits.

Personal protective equipment

Eye protection : Wear safety glasses with side shields or splash proof goggles.

Hand protection : Wear normal work gloves.

Skin protection : Wear suitable protective clothing.

Respiratory protection : Wear NIOSH-approved, European Standard EN 149 (FFP2/FFP3), AS/NZS 1715, or equivalent respirator when using this product. Handle only in a well-ventilated area.

Hygiene measures : Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.

Section: 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance : Powder

Colour	:	Off white to tan
Odour	:	Slight
Flash point	:	200.0 °F (93.3 °C) estimated
pH	:	7 (1%)
Odour Threshold	:	no data available
Melting point/freezing point	:	no data available
Initial boiling point and boiling range	:	no data available
Evaporation rate	:	no data available
Flammability (solid, gas)	:	no data available
Upper explosion limit	:	no data available
Lower explosion limit	:	no data available
Vapour pressure	:	no data available
Relative vapour density	:	no data available
Relative density	:	1.6
Density	:	42.5 lbs/ft^3
Water solubility	:	Soluble in water
Solubility in other solvents	:	no data available
Partition coefficient: n-octanol/water	:	no data available
Auto-ignition temperature	:	no data available
Thermal decomposition temperature	:	no data available
Viscosity, dynamic	:	no data available
Viscosity, kinematic	:	no data available
Molecular weight	:	1,000,000

Section: 10. STABILITY AND REACTIVITY

Chemical stability	:	Material is stable under normal conditions.
Possibility of hazardous reactions	:	Hazardous polymerization will not occur
Conditions to avoid	:	Avoid creation of dust when handling and avoid all possible sources of ignition (spark or flame. Take precautionary measures against electrostatic discharges. To avoid fire or explosion, dissipate static electricity by grounding and bonding containers and equipment before transferring material. Prevent dust accumulation.
Incompatible materials	:	Strong oxidizing agents.

Hazardous decomposition products : Carbon monoxide and carbon dioxide.

Section: 11. TOXICOLOGICAL INFORMATION

Information on likely routes of exposure : Eye, skin contact, inhalation

Potential Health Effects

Eyes : May cause mild irritation to the eye.

Skin : None known.

Ingestion : None known

Inhalation : May impede respiration

Acute oral toxicity : No data available

Acute inhalation toxicity : No data available

Acute dermal toxicity : No data available

Skin corrosion/irritation : No data available

Serious eye damage/eye irritation : May cause mild irritation to the eye.

Respiratory or skin sensitization : No data available

Carcinogenicity : No data available to indicate product or components present at greater than 0.1% are chronic health hazards

Section: 12. ECOLOGICAL INFORMATION

Ecotoxicity

Ecotoxicity for the component:

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Xanthan Gum	11138-66-2	>45,000 mg/kg (Rat)	No data available	>21 mg/L (Rat) 1h >4.25 mg/L (Rat) 4h

Substances	CAS Number	Skin corrosion/irritation
Xanthan Gum	11138-66-2	Non-irritating to the skin in rabbits

Substances	CAS Number	Eye damage/irritation
Xanthan Gum	11138-66-2	Mechanical irritation of the eyes is possible.

Substances	CAS Number	Skin Sensitization
Xanthan Gum	11138-66-2	No information available.

Substances	CAS Number	Respiratory Sensitization
Xanthan Gum	11138-66-2	No sensitation responses were observed

Substances	CAS Number	Mutagenic Effects
Xanthan Gum	11138-66-2	No information available

Substances	CAS Number	Carcinogenic Effects
Xanthan Gum	11138-66-2	Did not show carcinogenic effects in animal experiments

Substances	CAS Number	Reproductive toxicity
Xanthan Gum	11138-66-2	Animal testing did not show any effects on fertility

Substances	CAS Number	STOT - single exposure
Xanthan Gum	11138-66-2	No significant toxicity observed in animal studies at concentration requiring classification.

Substances	CAS Number	STOT - repeated exposure
Xanthan Gum	11138-66-2	No significant toxicity observed in animal studies at concentration requiring classification.

Substances	CAS Number	Aspiration hazard
Xanthan Gum	11138-66-2	Not applicalbe

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Xanthan Gum	11138-66-2	No information available	TLM96 320-560 ppm (Oncorhynchus mykiss) LC50 (96h) 490 mg/L (Oncorhynchus mykiss)	No information available	TLM96 >75,000 ppm (Mysidopsis bahia) LC50 (48h) 980 mg/L (Daphnia magna)

Environmental Effects : The product is not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment.

Persistence and degradability: no data available

Mobility: no data available

Bioaccumulative potential: no data available

Other information

No other adverse environmental effects (e.g. ozone depletion, photochemical ozone creation potential, endocrine disruption, global warming potential) are expected from this component.

Section: 13. DISPOSAL CONSIDERATIONS

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

Contaminated packaging	:	Since emptied containers may retain product residue, follow label warnings even after container is emptied. Empty containers should be taken to an approved waste handling site for recycling or disposal.

Section: 14. TRANSPORT INFORMATION

US D.O.T Non-bulk (packages less than 119 gallons).:

Land transport (DOT):

Not regulated as dangerous goods.

Air transport (IATA)

Not regulated as dangerous goods

Sea transport (IMDG/IMO)

Not regulated as dangerous goods

Section: 15. REGULATORY INFORMATION

This product is not known to be a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

TSCA list	:	All components listed on inventory or are exempt

EPA SARA Title III Extremely hazardous substances: Not applicable.

EPA SARA (311, 312) Hazard Class: None

EPA SARA (313) Chemicals: This product does not contain a toxic chemical for routine annual “Toxic Chemical Release Reporting” under Section 313 (10 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.

US STATE REGULATION:

US. California Controlled Substances. CA Department of Justice (California Health and Safety Code Section 11100): All components listed do not apply to the California Proposition 65 Regulation.

US. Massachusetts RTK - Substance List: Does not apply

US. New Jersey Worker and Community Right-to-Know Act: Does not apply

US. Pennsylvania Worker and Community Right-to-Know Law: Does not apply

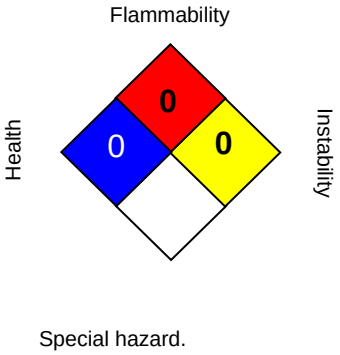
INTERNATIONAL CHEMICAL CONTROL LAWS:

United States TSCA Inventory: On TSCA Inventory

Canadian Domestic Substances List (DSL): On DSL Inventory

Section: 16. OTHER INFORMATION

NFPA:



HMIS III:

HEALTH	0
FLAMMABILITY	0
PHYSICAL HAZARD	0

0 = not significant, 1 =Slight,
2 = Moderate, 3 = High
4 = Extreme, * = Chronic

Revision Date	:	08/01/2018
Version Number	:	1.0

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

Safety Data Sheet
Sodium Carbonate, Anhydrous

Date Reviewed: September 2015 Supersedes: February 2015

This document has been prepared to meet the requirements of the U.S. OSHA Hazard Communication Standard, 29 CFR 1910.1200; the Canada's Workplace Hazards Materials Information System (WHMIS) and, the EC Directive, 2001/58/EC.

SECTION 1: Product and Company Identification

Product Name	Sodium Carbonate, Anhydrous
Alternate Product Name(s)	Soda Ash, Disodium Carbonate Also: Dense Soda Ash, Soda Ash Light, Synthetic Light Soda Ash, Soda Ash Liquid, Natural Light Soda Ash, Natural Light HA Soda Ash
Chemical Formula	Na_2CO_3
Product Use	Oil well drilling fluid additive. Calcium precipitation.

This chemical is certified to ANSI/NSF Standard 60, Drinking Water Chemicals – Health Effects (as packaged in the original, unopened container). Concentration not to exceed 100 ppm when used for corrosion control or scale control pH adjustment.

Supplier	Drillchem Drilling Solutions PO Box 132107 Spring, TX 77393
Telephone No.	Ph: (281) 713-8941
Emergency No.	(24 Hours) 800-424-9300 CHEMTREC

SECTION 2: Hazards Identification

***Emergency Overview*:**
White, odorless, granular solid. Product is non-combustible. Reacts with acids to release carbon dioxide gas and heat. May irritate skin and eyes. Dusts may irritate respiratory tract. Not expected to be toxic to the environment, nor to aquatic organisms. Avoid simultaneous exposure to soda ash and lime dust. In the presence of moisture (i.e. perspiration) the two materials combine to form caustic soda (NaOH), which may cause burns.

Hazard Classification:

Class	Category	Hazard Statement
Eye Irritant	Category 2	H319 Causes serious eye irritation

EC Labelling:

Name of Substance to appear on label	Sodium Carbonate
Symbol(s)	Xi- irritating 
Label Phrases	R36: Irritating to eyes. S26: In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. S2: Keep out of reach of children S22: Do not breath dust

Potential Health Effects:

Skin	Prolonged contact may cause skin irritation (red, dry, cracked skin).
Eyes	Irritating to the eyes.
Ingestions	Although low in toxicity, ingestion may cause nausea, vomiting, stomach ache, and diarrhea.
Inhalation	Prolonged inhalation of product dusts may irritate nose, throat, and lungs.
Chronic Effects	Excessive, long term contact may produce “soda ulcers” on hands and perforation of the nasal septum. Sensitivity reactions may occur from prolonged and repeated exposure. This product does not contain any ingredient designated by IARC, NTP, ACGIH or OSHA as probable or suspected human carcinogens.

SECTION 3: Composition/Information on Ingredients

Chemical Name	CAS #	Wt%	EC No.	EC Class
Sodium Carbonate	497-19-8	99.8	207-838-8	Xi, R36

SECTION 4: First Aid Measures

Skin	Wash with plenty of soap and water. Get medical attention if irritation occurs and persists. Remove and wash contaminated clothing before re-use.
Eyes	Immediately flush with water for at least 15 minutes lifting the upper and lower eyelids intermittently. See a medical doctor or ophthalmologist as necessary.
Ingestions	Rinse mouth with water. Dilute by giving 1 or 2 glasses of water. Do not induce vomiting. Never give anything by mouth to an unconscious person. If symptoms persist, contact a doctor or poison control center
Inhalation	Remove to fresh air. If breathing difficulty or discomfort occurs and persists, obtain medical attention.
Advice to Physician	While internal toxicity is low, irritant effects of high concentrations may produce corneal opacities, and vesicular skin reactions in humans with abraded skin only. Treatment is symptomatic and supportive.

SECTION 5: Firefighting measures

Extinguishing Media	Not combustible, use extinguishing method suitable for surrounding fire.
Fire/Explosion Hazards	Not applicable.
Fire Fighting Procedures	Wear full protective clothing and self-contained breathing apparatus
Flammable Limits	Not applicable
Auto-Ignition Temperature	Not applicable
Hazardous Combustion Products	Carbon dioxide.
Sensitivity to Impact	None
Sensitivity to Static Discharge	None

SECTION 6: Accidental Release Measures

Personal Precautions	Refer to Section 8 “Exposure Controls / Personal Protection”
Containment	Prevent large quantities of this product from contacting vegetation or waterways; large spills could kill vegetation and fish.
Clean Up	This product, if spilled, can be recovered and re-used if contamination does not present a problem. Vacuum or sweep up the material and collect in a suitable container for disposal. If the spilled product is unusable due to contamination, consult state or federal environmental agencies for acceptable disposal procedures and locations. See Section 13 “Disposal Considerations”.
Notification Requirements	Federal regulations do not require notification for spills of this product. State and local regulations may contain different requirements; consult local authorities.

SECTION 7: Handling and Storage

Handling	Use air conveying / mechanical systems for bulk transfer to storage. For manual handling of bulk transfer use mechanical ventilation to remove airborne dust from railcar, ship or truck. Use approved respiratory protection when ventilation systems are not available. Selection of respirators is based on the dust cloud generation. Keep material out of lakes, streams, ponds and sewer drains. Avoid eye contact or prolonged skin contact. Avoid breathing dusts. When dissolving, add to water cautiously and with stirring; solutions can get hot. Use good personal hygiene and housekeeping.
Storage	Store in a cool dry area, away from incompatible products (acids). Prolonged storage may cause product to cake from atmospheric moisture.

SECTION 8: Exposure Controls/ Personal Protection

Engineering Controls	Where possible, provide general mechanical and/or local exhaust ventilation to prevent release of airborne dust into the work environment. Eye wash facility should be provided in storage and general work area.

Personal Protective Equipment:

Eyes and Face	For dusty or misty conditions, or when handling solutions where there is reasonable probability of eye contact, wear chemical safety goggles and hardhat. Under these conditions do not wear contact lenses. Otherwise, appropriate eye and face protection equipment (ANSI Z87 approved) should be selected for the particular use intended for this material. Safety glasses with side shields are recommended.
Respiratory	Whenever dust in the worker's breathing zone cannot be controlled with ventilation or other engineering means, workers should wear respirators or dust masks approved by NIOSH/MSHA, EU CEN or comparable certification organization to protect them against airborne dust.
Hands, Body, and Arms	Wear long-sleeve shirt and trousers, and impervious gloves for routine product use. Cotton gloves are sufficient for dry product; wear impervious (e.g., rubber, neoprene, etc.) gloves when handling solutions. Protective shoes or boots.

Exposure Guidelines:
Federal guidelines treat the ingredient(s) in this product as a nuisance dust, as no product-specific guidelines have been issued for exposure. As with all nuisance dusts, worker breathing zone concentrations should be measured by validated sampling and analytical methods. The following limits (OSHA and MSHA) apply to this material:

Particulates Not Otherwise Regulated:
OSHA (PEL / TWA): 15 mg/m^3 (total dust); 5 mg/m^3 (rasp fraction) MSHA (PEL / TWA): 10 mg/m^3 (total dust)

SECTION 9: Physical and Chemical Properties

Appearance	White, granular solid
Odor	Odorless
Odor Threshold	Not applicable
Formula	Na_2CO_3
Molecular Weight	105.99
pH	11.3
Melting point/freezing point	854°C (1569°F)
Initial boiling point/boiling range	Decomposes
Flash point	None
Evaporation rate	Not Applicable
Flammability (solid, gas)	Not combustible
Flammability in Air	
Upper flammability limit	No information available
Lower flammability limit	No information available
Vapor Pressure	Not applicable
Vapor Density	Not applicable
Bulk Density (g/l)	Dense grades: 0.9 – 1.1 Natural light grade: 0.7 – 0.9 Synthetic light grade: 0.5 – 0.7
Specific Gravity	2.533 (vs. Water)
Water Solubility(ies)	212.5 g/l @ 20°C
Partition coefficient	No information available
Auto-ignition temperature	No information available
Decomposition temperature	400°C
Viscosity	
Viscosity, dynamic	No information available
Viscosity, cinematic	No information available
Percent Volatile	0%

SECTION 10: Stability and Reactivity

Stability	Stable
Conditions to Avoid	Contract with acids will release carbon dioxide, heat. Contract with lime dust in the presence of moisture can produce corrosive sodium hydroxide.
Materials to Avoid	May react with aluminum, acids, fluorine, lithium, and 2,4,6- Trinitrotoluene.
Polymerization	Will not occur.
Hazardous Decomposition	When heated to decomposition, carbon dioxide is released.
Other Precautions	When dissolving, add to water cautiously and with stirring; solutions can get hot.

SECTION 11: Toxicological Information

Eye	Severe irritant (50 mg, rabbit).
Skin	Mild irritant (500 mg/24hr, rabbit). Minor irritation may occur on abraded skin. Not a sensitizer (tested at 0.25% solution).
Oral	LD_{50}, rat: 4,090 mg/kg
Inhalation	LC_{50}, rat, 2hr 2.3 mg/l 24 – hour LC_{50}: 800 mg/m^3, 20 h exposure (guinea pig) (moderate toxicity)
Chronic	Excessive, long term contact may produce “soda ulcers” on hands and perforation of the nasal septum. Sensitivity reactions may occur from prolonged and repeated exposure.
Carcinogenicity	Not designated by IARC, NTP, ACGIH or OSHA as probable or suspected human carcinogens.

SECTION 12: Ecological Information

Acute Ecotoxicity	96 – hour LC_{50}: 265 – 565 mg/l (daphnia magnia) (low toxicity) 300 – 320 mg/l (blue gill sunfish) (low toxicity) 96 – hour TL_m: 1200 mg/l (mosquito-fish) 48 – hour TL_m: 840 mg/l (mosquito-fish) 48 – hour EC_{50}: 265 mg/l (daphnia magnia) 5 Day EC_{50}: 242 mg/l (Nitszcheria linearis)
Chronic Ecotoxicity	7 Day EC, biomass:14 mg/l (phytoplankton)
Mobility	Air: Not Applicable Water: Considerable solubility and mobility. Soil / sediments: Non-significant adsorption
Abiotic Degradation	Water (hydrolysis): degradation's products: carbonate (pH>10) / carbonic acid / carbon dioxide (pH<6). Soil**:** Hydrolysis as a function of pH.
Biotic Degradation	Aerobic / anaerobic: Not applicable (inorganic compound)
Potential for Bioaccumulation	Not applicable (ionizable inorganic compound)

Observed effects are related to alkaline properties of the product. Product is not significantly hazardous for the environment

SECTION 13: Disposal Considerations

Disposal Method	When this product is discarded or disposed of, as purchased, it is neither a characteristic nor a listed hazardous waste according to US Federal RCRA regulations (40 CFR 261). As a non-hazardous waste the material may be disposed of in a landfill in accordance with government regulations; check local or state regulations for applicable requirements prior to disposal. Any processing, usage, alteration, chemical additions to, or contamination of, the product may atler the disposal requirements. Under Federal Regulations, it is the generator's responsibility to determine if a waste is a hazardous waste.

SECTION 14: Transport Information

Proper Shipping Name	Not regulated
Primary Hazard Class/Division	Not regulated
UN/NA Number	Not applicable
Label(s), Placard(s), Marking(s)	Not applicable
Reportable Quantity (RQ)	None
49 STCC Number	Not Applicable
ADR (EU), TDG (Canada)	Not regulated
IMDG (sea), ICAO (air), IATA (air)	Not regulated

SECTION 15: Regulatory Information

SARA Title III (Superfund Amendments and Reauthorization Act)

Section 302 Extremely Hazardous Substances: 40CFR355, Appendix A	Not listed
Section 311 Hazard Class 40CFR370	Immediate (acute)
Section 312 Threshold Planning Quantity (TPQ) 40CFR370	No TPQ listed for sodium carbonate
Section 313 Reportable Ingredients 40CFR372	Not listed

CERCLA (Comprehensive Environmental Response Compensation and Liability Act):
40CFR302.4 – There is no listed RQ (reportable quantity) for this product.

TSCA (Toxic Substance Control Act)
This product is listed on the TSCA Inventory of Chemical Substances. No other TSCA rules affect this product

State Regulations:
This product does not contain any components that are regulated under California Proposition 65.

Other:
Clean Water Act (CWA) – Section 301/ 311: Not listed
Clean Air Act (CAA) – Section 112: Not regulated

CANADA:

WHMIS Classification	D2B Toxic Class E Corrosive Symbol:  This product has been classified in accordance with hazard criteria of the Controlled Products Regulations and the MSDS contains all the information required by the Controlled Products Regulations.
WHMIS Ingredient Disclosure List	Listed
DSL Status (Domestic Substances List)	Listed on DSL

EUROPEAN UNION:

EINECS Inventory	Listed: 207-838-8
Annex I (Substances Directive)	Listed: 011-005-00-2 Xi, R-36 (See label details in Section 16)
German Water Classification	Hazard class 1, low hazard to waters
EU – Food Additives Directive (95/2/EC) – Annex I – Generally Permitted for Use in Food	E500

INTERNATIONAL:

This product is also found in the chemical inventories of Australia, China, Korea, Japan and the Philippines.

SECTION 16: Other Information

HMIS (Hazardous Material Identification System)

Health	2
Flammability	0
Physical Hazard	0
Personal Protection (PPE)	B

Protection = B (Safety glasses and gloves)

4 = Severe, 3 = Serious, 2 = Moderate, 1 = Slight, 0 = Minimal

NFPA (National Fire Protection Association System)

Health	2
Flammability	0
Reactivity	0
Special	None

4 = Extreme, 3 = High, 2 = Moderate, 1 = Slight, 0 = Insignificant

Other Information:

Soda ash is produced in three principal grades: Dense, natural light and synthetic light soda ash. When these products are mixed in water they may be known as liquid soda ash. These grades differ only in physical characteristics such as bulk density and size and shape of particles, which influence flow characteristics and angle of repose. Other physical properties, as well as chemical as chemical properties of solutions, are common to each grade of soda ash.

Certified to ANSI / NSF 60

Concentration not to exceed 100 ppm when used for corrosion control or scale control pH adjustment.

WYO-BEN, INC.

SAFETY DATA SHEET

SECTION 1 — CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Trade Name: **WYO-VIS® DP**
Chemical Family: Water soluble polymer
Application: Drilling Fluid Additive

Manufacturer/Supplier: Wyo-Ben, Inc.
1345 Discovery Drive
Billings, MT 59102 USA
Telephone: 800.548.7055
Facsimile: 406.656.0748
Emergency Phone Number: CHEMTREC® 800.424.9300

SECTION 2 — HAZARD IDENTIFICATION

Hazard Classification: Not classified according to 29 CFR 1910.120 (d) and does not require a hazard warning label.

Signal Word: None

Hazard Statement: None

Hazard Symbol: None

Precautionary Statements

Prevention: None

Response: None

Storage: None

Disposal: None

Hazards Not Otherwise Classified: Aqueous solutions or powders that become wet cause surfaces to become extremely slippery.

SECTION 3 — COMPOSITION/INFORMATION ON INGREDIENTS

Contains no reportable hazardous substances.

SECTION 4 — FIRST AID MEASURES

Inhalation: If difficulties occur after dust has been inhaled, remove to fresh air. No hazards that require special first aid measures.

Skin: Wash thoroughly with soap and plenty of water. If irritation develops and persists seek medical attention.

Eyes: Rinse immediately with plenty of water for at least 15 minutes with eyelids held open. Seek medical attention if irritation persists.

Ingestion: Rinse mouth with water. Do NOT induce vomiting. No hazards which require special first aid measures.

Most important symptoms and effects, both acute and delayed

None

Indication of any immediate medical attention and special treatment needed

None reasonably foreseeable.

Other information

Aqueous solutions or powders that become wet cause surfaces to become extremely slippery.

SECTION 5 — FIRE FIGHTING MEASURES

Suitable Fire Extinguishing Media:	Water spray, alcohol-resistant foam, dry chemical or carbon-dioxide.
Unsuitable Extinguishing Media:	None
Special Exposure Hazards:	CAUTION! extremely slippery when wet.
Thermal Decomposition Products:	Oxides of carbon and nitrogen; Hydrogen cyanide may be produced in the event of combustion in an oxygen deficit atmosphere.
Special Protective Equipment for Firefighters:	Wear self-contained breathing apparatus (SCBA)
NFPA Rating:	Health 0, Flammability 0, Reactivity 0, PPE Code B

SECTION 6 — ACCIDENTAL RELEASE MEASURES

Personal Precautionary Measures:	Wear appropriate PPE (see Sec. 8).
Environmental Precautionary Measures:	Do not allow product to contaminate drains or surface water systems.
Procedure for Cleaning/Absorption:	Clean up promptly by sweeping or vacuum. Keep in suitable appliance or suitable container for disposal. After cleaning, flush away traces with water.
Further information:	CAUTION! extremely slippery when wet.

SECTION 7 — HANDLING AND STORAGE

Handling

General advice:	Handle in accordance with good industrial hygiene and safety practice. Aqueous solutions cause surfaces to become extremely slippery.

Storage

General advice:	Store in unopened original containers in a cool and dry place. Keep container closed when not in use. Incompatible with oxidizing agents

SECTION 8 — EXPOSURE CONTROLS/PERSONAL PROTECTION

Occupational exposure limits	None
Exposure controls:	Use local exhaust if dusting occurs. Natural ventilation is adequate in the absence of dust.

Personal protective equipment

Respiratory protection:	No personal protective equipment normally required. Dust safety masks recommended where working dust concentration is more than 10 mg/m^3.
Hand protection:	Chemical resistant protective gloves
Eye/face protection:	Safety glasses with side-shields.
Skin and Body protection:	Work clothes protecting arms, legs and body.

General safety and hygiene measures: Handle in accordance with good industrial hygiene and safety practice.

Environmental exposure controls: Do not allow uncontrolled discharge of product into the environment. Do not allow to enter surface waters,.

SECTION 9 — PHYSICAL AND CHEMICAL PROPERTIES

Physical State:	Granular solid
Color:	White
Odor:	odorless
pH:	5-9 (0.5% aqueous solution)
Specific Gravity @ 20 C (Water=1):	No data available
Bulk Density @ 20 C (KG/M^3):	600 - 900
Boiling Point/Range (F/C):	Not applicable
Melting Point/Range (F/C):	<302 / 150
Vapor Pressure @ 20 C (mmHg):	Not applicable
Vapor Density (Air=1):	Not applicable
Percent Volatiles:	Not applicable
Evaporation Rate (Butyl Acetate=1):	Not applicable
Solubility in Water (g/100ml):	Soluble
Solubility in Solvents (g/100ml):	Not determined
Decomposition Temperature:	>150C
Partition Coefficient:	-2
Flash Point/Range (F/C):	Not applicable
Autoignition Temperature (F/C):	Not applicable – does not autoignite (based on the chemical structure).
Explosive properties:	Kst = 0 Non-flammable to ignition sources of less than 2.5kJ

SECTION 10 — STABILITY AND REACTIVITY

Reactivity:	None known
Stability Data:	Stable under normal conditions
Hazardous Reactions:	Oxidizing agents may cause exothermic reactions.
Conditions to Avoid:	None known.
Incompatibility (Materials to Avoid):	Oxidizing agents.
Hazardous Decomposition Products:	Thermal decomposition may produce oxides of carbon (COx) and nitrogen (NOx); Hydrogen cyanide may be produced if oxygen is deficient.

SECTION 11 — TOXICOLOGICAL INFORMATION

Acute Oral Toxicity:	LD50/Rat/> 5000 mg/kg
Acute Dermal Toxicity:	LD50/Rat/> 5000 mg/kg
Acute Inhalation Toxicity:	Product is not expected to be toxic by inhalation.
Skin Corrosion / Irritation:	Non-irritating.
Serious Eye Damage / Irritation:	Not irritating
Respiratory / Skin Sensitization:	Not sensitizing.
Mutagenicity:	Not mutagenic
Carcinogenicity:	Not carcinogenic
Reproductive Toxicity:	Not a reproductive toxin.
STOT – single exposure:	No known effects
STOT – repeated exposure:	No known effects
Aspiration Hazard:	No hazards from the material as supplied.

SECTION 12 — ECOLOGICAL INFORMATION

Toxicity

Acute Fish Toxicity:	LC50/ Oncorhynchus mykiss /96 hours > 100 mg/l (OECD 203)
Acute Daphnia Toxicity:	EC50/Daphnia magna (Water Flea)/48 hours > 100 mg/l (OECD 202)
Acute Algae Toxicity:	IC50/Scenedesmus subspicatus/72 hours > 100 mg/L (OECD 201)
Chronic toxicity to fish:	No data available
Chronic toxicity to invertebrates:	No data available
Toxicity to microorganisms:	No data available
Effects on terrestrial organisms:	No known effects
Sediment toxicity:	No data available

Persistence/Degradability

Degradation:	Not readily biodegradable.
Hydrolysis:	Does not hydrolyze.
Photolysis:	No data available.

Bioaccumulative potential

Non-bioaccumulating	
Partition coefficient (log Pow):	-2
Bioconcentration factor (BCF):	~0

Mobility in soil: Not determined.

SECTION 13 — DISPOSAL CONSIDERATIONS

Disposal Method:	Landfill or incinerate in accordance with federal, state and local regulations.
Contaminated Packaging:	Rinse empty containers with water and use the rinse water to prepare additional working solutions. Can be landfilled or incinerated, in compliance with local, state and federal regulations.

SECTION 14 — TRANSPORT INFORMATION

Land Transportation

DOT – Not classified

Canadian TDG – Not classified

Air Transportation

ICAO/IATA – Not classified

Sea Transportation

IMDG – Not classified

SECTION 15 — REGULATORY INFORMATION

US Regulations

US TSCA Inventory	All components are either listed on the inventory or are exempt from listing.
EPA SARA Title III Extremely Hazardous Substances	Not applicable, non-hazardous
EPA SARA (311, 312) Hazard Class	Not applicable, Non-hazardous
EPA RCRA Hazardous Waste Classification	Not considered a hazardous waste as defined by 40 CFR 261.
California Proposition 65:	WARNING! This product contains a chemical which is known to the State of California to cause cancer, birth defects or other reproductive harm. Acrylamide.

SECTION 16 — OTHER INFORMATION

Prepared 3/20/2015

Last Revision 8/31/2015

DISCLAIMER

All information presented herein is believed to be accurate; however, it is the user's responsibility to determine in advance of need that the information is current and suitable for their circumstances. No warranty or guarantee, expressed or implied is made by WYO-BEN, INC. as to this information, or as to the safety, toxicity or effect of the use of this product.

SAFETY DATA SHEET

1. Identification

Product identifier	SUPER GEL-X®
Other means of identification	None.
Recommended use	Not available.
Recommended restrictions	Workers (and your customers or users in the case of resale) should be informed of the potential presence of respirable dust and respirable crystalline silica as well as their potential hazards. Appropriate training in the proper use and handling of this material should be provided as required under applicable regulations.

Manufacturer/Importer/Supplier/Distributor information

Manufacturer

Company name	CETCO, an MTI Company	
Address	2870 Forbs Avenue Hoffman Estates, IL 60192 United States	
Telephone	General Information	800 527-9948
Website	http://www.cetco.com/	
E-mail	safetydata@amcol.com	
Emergency phone number	.	
Americas	1.866.519.4752 (US, Canada, Mexico) 1 760 476 3962 Access Code 333562	

2. Hazard(s) identification

Physical hazards	Not classified.
Health hazards	Not classified.
Environmental hazards	Not classified.
OSHA defined hazards	Not classified.

Label elements

Hazard symbol	None.
Signal word	None.
Hazard statement	Not applicable.
Precautionary statement	
Prevention	Observe good industrial hygiene practices.
Response	Wash hands after handling.
Storage	Store away from incompatible materials.
Disposal	Dispose of waste and residues in accordance with local authority requirements.
Hazard(s) not otherwise classified (HNOC)	None known.
Supplemental information	Not applicable.

3. Composition/information on ingredients

Mixtures

Chemical name	Common name and synonyms	CAS number	%
TRADE SECRET*		Proprietary*	< 0.1
Other components below reportable levels			90 - 100

Constituents

Chemical name	CAS number	%
CALCIUM CARBONATE	471-34-1	
SMECTITE GROUP MINERALS	1318-93-0	

Constituents

Chemical name	CAS number	%
QUARTZ	14808-60-7	<= 8
CRISTOBALITE	14464-46-1	<= 2

*Designates that a specific chemical identity and/or percentage of composition has been withheld as a trade secret. Bentonite is a UVCB substance sub-type 4. The purity of the product is 100 % w/w. Bentonite is composed mainly of smectite group minerals but the composition is varied, as expected for a UVCB substance, and other mineral constituents will be present in small and varying amounts. These minor constituents are not relevant for classification and labelling.

Composition comments	Occupational Exposure Limits for constituents are listed in Section 8. The purity of the product is 100% w/w. Impurities are not applicable for a UVCB substance.

4. First-aid measures

Inhalation	If dust from the material is inhaled, remove the affected person immediately to fresh air. Call a physician if symptoms develop or persist. No specific first aid measures noted.
Skin contact	No specific first aid measures noted. Get medical attention if irritation develops and persists. Wash skin with soap and water.
Eye contact	No specific first aid measures noted.
Ingestion	No specific first aid measures noted. Rinse mouth thoroughly. Get medical attention if any discomfort occurs.
Most important symptoms/effects, acute and delayed	Dust in the eyes will cause irritation.
Indication of immediate medical attention and special treatment needed	Provide general supportive measures and treat symptomatically.
General information	No hazards which require special first aid measures. Provide general supportive measures and treat symptomatically.

5. Fire-fighting measures

Suitable extinguishing media	Water fog. Foam. Dry chemical powder. Carbon dioxide (CO2). Use any media suitable for the surrounding fires.
Unsuitable extinguishing media	Not applicable, non-combustible.
Specific hazards arising from the chemical	None known. The product itself does not burn.
Special protective equipment and precautions for firefighters	Material can be slippery when wet.
Fire fighting equipment/instructions	In the event of fire, cool tanks with water spray. Material can be slippery when wet.
Specific methods	Cool containers exposed to flames with water until well after the fire is out.
General fire hazards	No unusual fire or explosion hazards noted. This material will not burn.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures	Keep unnecessary personnel away. Material can be slippery when wet. Use a NIOSH/MSHA approved respirator if there is a risk of exposure to dust/fume at levels exceeding the exposure limits. Avoid inhalation of dust from the spilled material. For personal protection, see section 8 of the SDS. No special precautions are necessary beyond normal good hygiene practices. See Section 8 for additional personal protection advice when handling this product.
Methods and materials for containment and cleaning up	If sweeping of a contaminated area is necessary use a dust suppressant agent which does not react with the product. Sweep up or vacuum up spillage and collect in suitable container for disposal. Collect dust using a vacuum cleaner equipped with HEPA filter. Minimize dust generation and accumulation. Avoid the generation of dusts during clean-up. Following product recovery, flush area with water. For waste disposal, see section 13 of the SDS. Collect powder using special dust vacuum cleaner with particle filter or carefully sweep into closed container.
Environmental precautions	Prevent further leakage or spillage if safe to do so. No special environmental precautions required.

7. Handling and storage

Precautions for safe handling	Minimize dust generation and accumulation. Provide appropriate exhaust ventilation at places where dust is formed. Avoid breathing dust. Avoid contact with skin and eyes. In case of insufficient ventilation, wear suitable respiratory equipment. Practice good housekeeping.

Conditions for safe storage, including any incompatibilities	No special restrictions on storage with other products. Store in a dry area. Store in original tightly closed container. Keep the container dry. Store in a well-ventilated place. Store away from incompatible materials (see Section 10 of the SDS). Guard against dust accumulation of this material.

8. Exposure controls/personal protection

Occupational exposure limits

US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000)

Constituents	Type	Value	Form
INERT OR NUISANCE DUSTS	PEL	5 mg/m3	Respirable fraction.
		15 mg/m3	Total dust.

US. OSHA Table Z-3 (29 CFR 1910.1000)

Constituents	Type	Value	Form
INERT OR NUISANCE DUSTS	TWA	5 mg/m3	Respirable fraction.
		15 mg/m3	Total dust.
		50 mppcf	Total dust.
		15 mppcf	Respirable fraction.

US. ACGIH Threshold Limit Values

Components	Type	Value
TRADE SECRET	TWA	2 ppm

US. NIOSH: Pocket Guide to Chemical Hazards

Components	Type	Value
TRADE SECRET	TWA	6 mg/m3
		2 ppm

Biological limit values: No biological exposure limits noted for the ingredient(s).

Exposure guidelines

US - California OELs: Skin designation

TRADE SECRET (CAS Proprietary): Can be absorbed through the skin.

US - Tennessee OELs: Skin designation

TRADE SECRET (CAS Proprietary): Can be absorbed through the skin.

US ACGIH Threshold Limit Values: Skin designation

TRADE SECRET (CAS Proprietary): Can be absorbed through the skin.

US NIOSH Pocket Guide to Chemical Hazards: Skin designation

TRADE SECRET (CAS Proprietary): Can be absorbed through the skin.

Appropriate engineering controls: Ventilation should be sufficient to effectively remove and prevent buildup of any dusts or fumes that may be generated during handling or thermal processing. If engineering measures are not sufficient to maintain concentrations of dust particulates below the OEL, suitable respiratory protection must be worn.

Individual protection measures, such as personal protective equipment

Eye/face protection: Use tight fitting goggles if dust is generated. Wear dust-resistant safety goggles where there is danger of eye contact.

Skin protection

Hand protection: No protection is ordinarily required under normal conditions of use.

Other: Normal work clothing (long sleeved shirts and long pants) is recommended.

Respiratory protection: Use a NIOSH/MSHA approved respirator if there is a risk of exposure to dust/fume at levels exceeding the exposure limits.

Thermal hazards: Not applicable.

General hygiene considerations: Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants. Use good industrial hygiene practices in handling this material.

9. Physical and chemical properties

Appearance: Lump, granular or fine powder.

Physical state: Solid.

Form	Powder. Various.
Color	Various.
Odor	None.
Odor threshold	Not applicable.
pH	8.5 - 11
Melting point/freezing point	> 842 °F (> 450 °C) / Not applicable.
Initial boiling point and boiling range	Not applicable.
Flash point	Not applicable.
Evaporation rate	Not available.
Flammability (solid, gas)	This product is not flammable.
Upper/lower flammability or explosive limits	
Flammability limit - lower (%)	Not applicable.
Flammability limit - upper (%)	Not applicable.
Explosive limit - lower (%)	Not available.
Explosive limit - upper (%)	Not available.
Vapor pressure	Not applicable.
Vapor density	Not applicable.
Relative density	2.6 g/cm³
Solubility(ies)	
Solubility (water)	< 0.9 mg/l
Partition coefficient (n-octanol/water)	Not applicable. Not applicable.
Auto-ignition temperature	Not applicable.
Decomposition temperature	> 932 °F (> 500 °C)
Viscosity	Not applicable.
Viscosity temperature	Not applicable.
Other information	
Bulk density	0.9 - 1.4 g/cm³
Explosive limit	Not applicable.
Explosive properties	Not explosive
Explosivity	Not applicable.
Flame extension	Not applicable.
Flammability	Not applicable.
Flammability (flash back)	Not applicable.
Flammability (Heat of combustion)	Not applicable.
Flammability (Train fire)	Not applicable.
Flammability class	Not applicable.
Flash point class	Not flammable
Molecular formula	UVCB Substance
Molecular weight	Not applicable.
Oxidizing properties	None.
Percent volatile	0 %
pH in aqueous solution	8.5 - 11
Specific gravity	Not applicable.
VOC (Weight %)	CARB 0 %

10. Stability and reactivity

Reactivity	The product is stable and non-reactive under normal conditions of use, storage and transport.
Chemical stability	Stable at normal conditions.
Possibility of hazardous reactions	Will not occur.
Conditions to avoid	Moisture. Avoid temperatures exceeding the decomposition temperature. Contact with incompatible materials. Avoid dispersal of dust in the air (i.e., clearing dust surfaces with compressed air).
Incompatible materials	None known.
Hazardous decomposition products	None.

11. Toxicological information

Information on likely routes of exposure

Inhalation	Inhalation of dusts may cause respiratory irritation.
Skin contact	Not classified.
Eye contact	Dust in the eyes will cause irritation.
Ingestion	Not classified.
Symptoms related to the physical, chemical and toxicological characteristics	None known.

Information on toxicological effects

Product	Species	Test Results
Bentonite		
Acute		
Inhalation		
Dust		
LC50	Rat	> 5.27 mg/l, 4 hr OECD 436
Oral		
Dust		
LD50	Rat	> 2000 mg/kg OECD 425
Components	**Species**	**Test Results**
TRADE SECRET		
Acute		
Inhalation		
LC50	Rat	10600 mg/l/4h
		1200 mg/l, 4 Hours
Oral		
LD50	Mouse	2400 mg/kg
	Rat	33.5 mg/kg

* Estimates for product may be based on additional component data not shown.

Skin corrosion/irritation	Not classified.
Serious eye damage/eye irritation	Dust in the eyes will cause irritation. Mild irritant to eyes (according to the modified Kay & Calandra criteria)
Respiratory or skin sensitization	
Respiratory sensitization	Not classified.
Skin sensitization	Not classified.
Germ cell mutagenicity	Not classified.

Carcinogenicity	In June 2003, SCOEL (the EU Scientific Committee on Occupational Exposure Limits) concluded that the main effect in humans of the inhalation of respirable crystalline silica dust is silicosis. "There is sufficient information to conclude that the relative risk of lung cancer is increased in persons with silicosis (and, apparently, not in employees without silicosis exposed to silica dust in quarries and in the ceramic industry). Therefore, preventing the onset of silicosis will also reduce the cancer risk..." (SCOEL SUM Doc 94-final, June 2003) According to the current state of the art, worker protection against silicosis can be consistently assured by respecting the existing regulatory occupational exposure limits. Occupational exposure to respirable dust and respirable crystalline silica should be monitored and controlled. No carcinogenicity data available for this product. Sepiolite was evaluated by IARC as class 3 ("Cannot be classified as to carcinogenicity to humans"). Based on read-across with sepiolite, bentonite was assessed as non-carcinogenic. Therefore classification of bentonite for carcinogenicity is not warranted.

IARC Monographs. Overall Evaluation of Carcinogenicity

TRADE SECRET (CAS Proprietary)	3 Not classifiable as to carcinogenicity to humans.

Reproductive toxicity	Not classified.
Specific target organ toxicity - single exposure	Not classified.
Specific target organ toxicity - repeated exposure	Not classified.
Aspiration hazard	Not available.

12. Ecological information

Ecotoxicity — The product is not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment.

Product		Species	Test Results
Bentonite			
Aquatic			
Algae	EC50	Freshwater algae	> 100 mg/l, 72 hours
Crustacea	EC50	Coon stripe shrimp (Pandalus danae)	24.8 mg/l, 96 hours
		Daphnia	> 100 mg/l, 48 hours
		Dungeness or edible crab (Cancer magister)	81.6 mg/l, 96 hours
Fish	LC50	Freshwater fish	16000 mg/l, 96 hours
		Marine water fish	2800 - 3200 mg/l, 24 hours

Components		Species	Test Results
TRADE SECRET			
Aquatic			
Crustacea	EC50	Daphnia	47 mg/L, 48 Hours
Fish	LC50	Fish	222 mg/L, 96 Hours

* Estimates for product may be based on additional component data not shown.

Persistence and degradability	Not relevant for inorganic substances
Bioaccumulative potential	Will not bio-accumulate.

Partition coefficient n-octanol / water (log Kow)

TRADE SECRET	0.35

Mobility in soil	Bentonite is almost insoluble and thus presents a low mobility in most soils.
Mobility in general	The product has poor water-solubility.
Other adverse effects	No other adverse environmental effects (e.g. ozone depletion, photochemical ozone creation potential, endocrine disruption, global warming potential) are expected from this component.

13. Disposal considerations

Disposal instructions	Collect and reclaim or dispose in sealed containers at licensed waste disposal site. Dispose in accordance with all applicable regulations.
Local disposal regulations	Dispose in accordance with all applicable regulations.
Hazardous waste code	The waste code should be assigned in discussion between the user, the producer and the waste disposal company.

Waste from residues / unused products	Dispose of in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner (see: Disposal instructions).
Contaminated packaging	Empty containers should be taken to an approved waste handling site for recycling or disposal. Since emptied containers may retain product residue, follow label warnings even after container is emptied. Store containers and offer for recycling of material when in accordance with the local regulations.

14. Transport information

DOT

Not regulated as dangerous goods.

IATA

Not regulated as dangerous goods.

IMDG

Not regulated as dangerous goods.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code	Not applicable.

15. Regulatory information

US federal regulations

CERCLA Hazardous Substance List (40 CFR 302.4)

TRADE SECRET (CAS Proprietary) Listed.

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Hazard categories	Immediate Hazard - No Delayed Hazard - No Fire Hazard - No Pressure Hazard - No Reactivity Hazard - No

SARA 302 Extremely hazardous substance

Not listed.

SARA 311/312 Hazardous chemical	No

SARA 313 (TRI reporting)

Not regulated.

Other federal regulations

Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List

TRADE SECRET (CAS Proprietary)

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)

Not regulated.

Safe Drinking Water Act (SDWA)	Not regulated.
Food and Drug Administration (FDA)	Total food additive Direct food additive GRAS food additive

US state regulations

US - New Jersey RTK - Substances: Listed substance

TRADE SECRET (CAS Proprietary)

US - Pennsylvania RTK - Hazardous Substances: Listed substance

TRADE SECRET (CAS Proprietary)

US. California Controlled Substances. CA Department of Justice (California Health and Safety Code Section 11100)

Not listed.

US. California. Candidate Chemicals List. Safer Consumer Products Regulations (Cal. Code Regs, tit. 22, 69502.3, subd. (a))

TRADE SECRET (CAS Proprietary)

US. Massachusetts RTK - Substance List

TRADE SECRET (CAS Proprietary)

US. New Jersey Worker and Community Right-to-Know Act

TRADE SECRET (CAS Proprietary)

US. Pennsylvania Worker and Community Right-to-Know Law

TRADE SECRET (CAS Proprietary)

US. Rhode Island RTK

TRADE SECRET (CAS Proprietary)

US. California Proposition 65

California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65): This material is not known to contain any chemicals currently listed as carcinogens or reproductive toxins.

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	No
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	No
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates that all components of this product comply with the inventory requirements administered by the governing country(s)
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information, including date of preparation or last revision

Issue date	10-October-2013
Revision date	24-July-2015
Version #	20
Further information	This safety datasheet only contains information relating to safety and does not replace any product information or product specification. UVCB = a substance of Unknown or Variable composition, Complex reaction products or Biological materials SWERF = Size Weighted Respirable Fraction methodology is a scientific method developed to quantify the content of respirable particles within a bulk product. All details about the SWERF method are available at www.crystallinesilica.eu. HMIS® is a registered trade and service mark of the NPCA.
HMIS® ratings	Health: 1 Flammability: 0 Physical hazard: 0
NFPA ratings	Health: 1 Flammability: 0 Instability: 0
List of abbreviations	SWERF = Size-Weighted Relevant Fine Fraction methodology is a scientific method developed to quantify the content of respirable particles within a bulk product. All details about the SWERF method are available at www.crystallinesilica.eu. UVCB = a substance of Unknown or Variable composition, Complex reaction products or Biological materials
References	For any information on literature references or toxicity/ecotoxicity studies, please contact the supplier.

Disclaimer	The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The manufacturer expressly does not make any representations, warranties, or guarantees as to its accuracy, reliability or completeness nor assumes any liability, for its use. It is the user's responsibility to verify the suitability and completeness of such information for each particular use. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text. The information in the sheet was written based on the best knowledge and experience currently available.
Revision Information	This document has undergone significant changes and should be reviewed in its entirety.

United States Steel Corporation

Standard Pipe

Safety Data Sheet (SDS)

USS IHS Number: 73711

(Replaces USS Code Number: 4A018, 4C018, 4H018)

Locations: LTO, FFTO, LSTO

Section 1 – Identification

1(a) Product Identifier Used on Label: Standard Pipe

1(b) Other Means of Identification: Carbon Steel Pipe, Alloy Steel Pipe, HSLA Steel Pipe

1(c) Recommended Use of the Chemical and Restrictions on Use: None

1(d) Name, Address, and Telephone Number:

United States Steel Corporation
600 Grant Street, Room 1662
Pittsburgh, PA 15219-2800

Phone number : (412) 433-6840 (8:00 am to 5:00 pm)
FAX: (412) 433-5019

1(e) Emergency Phone Number: 1-800-262-8200 (CHEMTREC)

Section 2 – Hazard(s) Identification

2(a) Classification of the Chemical: As sold, this product, **Standard Pipe** is not hazardous according to the criteria specified in REACH [REGULATION (EC) No 1907/2006] and CLP [REGULATION (EC) No 1272/2008]. Under 29 CFR 1910.1200 Hazard Communication Standard, steel products are considered mixtures due to further processing which may produce dusts and or fume. The categories of Health Hazards as defined in "GLOBALLY HARMONIZED SYSTEM OF CLASSIFICATION AND LABELLING OF CHEMICALS (GHS), Third revised edition ST/SG/AC.10/30/Rev. 3" United Nations, New York and Geneva, 2009 have been evaluated. Refer to Section 3, 8 and 11 for additional information. Precautionary Statement/Emergency Overview: This formed solid metal product poses little or no immediate health or fire hazard. When product is subjected to welding, burning, melting, sawing, brazing, grinding or other similar processes, potentially hazardous airborne particulate and fumes may be generated.

2(b) Signal Word, Hazard Statement(s), Symbols and Precautionary Statement(s):

Hazard Symbol	Hazard Classification	Signal Word	Hazard Statement(s)	Precautionary Statement(s)
	Carcinogenicity - 2 Toxic to Reproduction - 2 Single Target Organ Toxicity (STOT) Repeat Exposure -1	**Danger**	Suspected of causing cancer. Suspected of damaging fertility or the unborn child. Causes damage to lungs through prolonged or repeated inhalation exposure. Harmful if swallowed. May cause an allergic skin reaction. May cause respiratory irritation. Causes eye irritation.	Do not breathe dusts / fume / spray. Wear protective gloves / protective clothing / eye protection / face protection. Contaminated work clothing must not be allowed out of the workplace. Use only outdoors or in well ventilated areas. Wash thoroughly after handling. Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Do not eat, drink or smoke when using this product. If inhaled: Remove person to fresh air and keep comfortable for breathing. If exposed, concerned or feel unwell: Get medical advice/attention. If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If on skin: Wash with plenty of water. If irritation or rash occurs: Get medical advice/attention. Take off contaminated clothing and wash before reuse. Dispose of contents in accordance with federal, state and local regulations.
	Acute Toxicity-Oral 4 Skin Sensitization - 1 STOT Single Exposure - 3			
NA	Eye Irritation - 2B			

2(c) Hazards Not Otherwise Classified: None Known

2(d) Unknown Acute Toxicity Statement (mixture): None Known

Section 3 – Composition/Information on Ingredients

3(a-c) Chemical Name, Common Name (synonyms), CAS Number and Other Identifiers, and Concentration:

Chemical Name	CAS Number	EC Number	% weight
Iron	7439-89-6	231-096-4	>95
Chromium	7440-47-3	231-157-5	≤2.0
Copper	7440-50-8	231-159-6	≤1.0
Manganese	7439-96-5	231-105-1	≤2.5
Molybdenum	7439-98-7	231-107-2	≤1.0
Nickel	7440-02-0	231-111-4	≤1.0
Silicon	7440-21-3	231-130-8	≤1.5

EC- European Community
CAS- Chemical Abstract Service

Section 4 – First-aid Measures

4(a) Description of Necessary Measures: If exposed, concerned or feel unwell: Get medical advice/attention.

- **Inhalation: Standard Pipe** as sold/shipped is not a likely form of exposure. However during further processing (welding, grinding, burning, etc.). If inhaled: Remove person to fresh air and keep comfortable for breathing. If exposed, concerned or feel unwell: Get medical advice/attention.
- **Eye Contact:** This product as sold/shipped is not a likely form of exposure. However during further processing (welding, grinding, burning, etc.). If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue Rinsing. If eye irritation persists: Get medical advice/attention. If exposed, concerned or feel unwell: Get medical advice/attention.
- **Skin Contact:** If on skin: Wash thoroughly after handling. Wash with plenty of water. If irritation or rash occurs: Get medical advice/attention. Take off and wash contaminated clothing before reuse.
- **Ingestion:** This product as sold/shipped is not a likely form of exposure. However during further processing (welding, grinding, burning, etc.). If swallowed: Call a poison center/doctor if you feel unwell. Rinse mouth. If exposed, concerned or feel unwell: Get medical advice/attention.

4(b) Most Important Symptoms/Effects, Acute and Delayed (chronic):

- **Inhalation:** This product as sold/shipped is not likely to present an acute or chronic health effect.
- **Eye:** This product as sold/shipped is not likely to present an acute or chronic health effect.
- **Skin:** This product as sold/shipped is not likely to present an acute or chronic health effect.
- **Ingestion:** This product as sold/shipped is not likely to present an acute or chronic health effect.

4(c) Immediate Medical Attention and Special Treatment: None Known

Section 5 – Fire-fighting Measures

5(a) Suitable (and unsuitable) Extinguishing Media: Not applicable for **Standard Pipe** as sold/shipped. Use extinguishers appropriate for surrounding materials.

5(b) Specific Hazards Arising From the Chemical: Not applicable for this product as sold/shipped. When burned, toxic smoke and vapor may be emitted.

5(c) Special Protective Equipment and Precautions for Fire-fighters: Self-contained NIOSH approved respiratory protection and full protective clothing should be worn when fumes and/or smoke from fire are present. Heat and flames cause emittance of acrid smoke and fumes. Do not release runoff from fire control methods to sewers or waterways. Firefighters should wear full face-piece self-contained breathing apparatus and chemical protective clothing with thermal protection. Direct water stream will scatter and spread flames and, therefore, should not be used.

Section 6 - Accidental Release Measures

6(a) Personal Precautions, Protective Equipment and Emergency Procedures: Not applicable for **Standard Pipe** as sold/shipped. For spills involving finely divided particles, clean-up personnel should be protected against contact with eyes and skin.

6(b) Methods and Materials for Containment and Clean Up: Not applicable for this product as sold/shipped. If material is in a dry state, avoid inhalation of dust. Fine, dry material should be removed by vacuuming or wet sweeping methods to prevent spreading of dust. Avoid using compressed air. Do not release into sewers or waterways. Collect material in appropriate, labeled containers for recovery or disposal in accordance with federal, state, and local regulations. Follow applicable OSHA regulations (29 CFR 1910.120) and all other pertinent state and federal requirements.

Section 7 - Handling and Storage

7(a) Precautions for Safe Handling: Not applicable for **Standard Pipe** as sold/shipped, however further processing (welding, burning, grinding, etc.) with the potential for generating high concentrations of airborne particulates should be evaluated and controlled as necessary. Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Practice good housekeeping. Avoid breathing metal fumes and/or dust. Do not eat, drink or smoke when using this product.

7(b) Conditions for Safe Storage, Including any Incompatibilities: Store away from acids and incompatible materials.

Section 8 - Exposure Controls / Personal Protection

8(a) Occupational Exposure Limits (OELs): Standard Pipe as sold/shipped in its physical form does not present an inhalation, ingestion or contact hazard, nor would any of the following exposure data apply. However, operations such as high temperature (burning, welding, sawing, brazing, machining and grinding) may produce fumes and/or particulates. The following exposure limits are offered as reference, for an experience industrial hygienist to review.

Ingredients	8(a) OSHA PEL [1]	ACGIH TLV [2]	NIOSH REL [3]	IDLH [4]
Iron	10 mg/m³ (as iron oxide fume)	5.0 mg/m³ (as iron oxide dust and fume)	5.0 mg/m³ (as iron oxide dust and fume)	2,500 mg Fe/m^3
Chromium	0.5 mg/m³ (as Cr II & III, inorganic compounds) 1.0 mg/m³ (as Cr, metal) 0.005 mg/m³ (as Cr VI, inorganic compounds & certain water insoluble) "AL" 0.0025 mg/m³ (as Cr VI, inorganic compounds & certain water insoluble)	0.5 mg/m³ (as Cr III, inorganic compounds) 0.5 mg/m³ (as Cr, metal) 0.05 mg/m³ (as Cr VI, inorganic compounds) 0.01 mg/m³ (as Cr VI, inorganic compounds & certain water insoluble)	0.5 mg/m³ (as Cr II & III, inorganic compounds) 0.5 mg/m³ (as Cr, metal) 0.001 mg/m³ (as Cr VI, inorganic compounds & certain water insoluble)	250 mg/m³ (as Cr II & metal) 25 mg/m³ (as Cr III) 15 mg/m³ (as Cr VI)
Copper	0.1 mg/m³ (as fume, Cu) 1.0 mg/m³ (as dusts & mists, Cu)	0.1 mg/m³ (as fume) 1.0 mg/m³ (as dusts & mists, Cu)	1.0 mg/m³ (as dusts & mists)	100 mg Cu/m^3
Manganese	"C" 5.0 mg/m³ (as Fume & Mn compounds)	0.2 mg/m³	"C" 5.0 mg/m³ 1.0 mg/m³ (as fume) "STEL" 3.0 mg/m³	500 mg Mn/m^3
Molybdenum	15 mg/m³ (as total dust, PNOR[5]) 5.0 mg/m³ (as respirable fraction, PNOR)	10 mg/m³ (as Mo insoluble compounds, inhalable fraction[6]) 3.0 mg/m³ (as Mo insoluble compounds, respirable fraction[7]) 0.5 mg/m³ (as Mo soluble compounds, respirable fraction)	NE	NE
Nickel	1.0 mg/m³ (as Ni metal & insoluble compounds)	1.5 mg/m³ (as inhalable fraction Ni metal) 0.2 mg/m³ (as inhalable fraction Ni inorganic only insoluble and soluble compounds)	0.015 mg/m³ (as Ni metal & insoluble and soluble compounds)	10 mg/m³ (as Ni)
Silicon	15 mg/m³ (total dust, PNOR) 5.0 mg/m³ (as respirable fraction, PNOR)	10 mg/m³	10 mg/m³ (as total dust) 5.0 mg/m³ (as respirable dust)	NE

NE - None Established

1. OSHA PELs (Permissible Exposure Limits) are 8-hour TWA (Time-Weighted Average) concentrations unless otherwise noted. A ("C") designation denotes a ceiling limit, which should not be exceeded during any part of the working exposure unless otherwise noted. An Action level (AL) is used by OSHA and NIOSH to express a health or physical hazard. They indicate the level of a harmful or toxic substance/activity, which requires medical surveillance, increased industrial hygiene monitoring, or biological monitoring. Action Levels are generally set at one half of the PEL but the actual level may vary from standard to standard. The intent is to identify a level at which the vast majority of randomly sampled exposures will be below the PEL.
2. Threshold Limit Values (TLV) established by the American Conference of Governmental Industrial Hygienists (ACGIH) are 8-hour TWA concentrations unless otherwise noted. ACGIH TLVs are for guideline purposes only and as such are not legal, regulatory limits for compliance purposes. A Short Term Exposure Limit (STEL) is defined as the maximum concentration to which workers can be exposed for a short period of time (15 minutes) for only four times throughout the day with at least one hour between exposures.
3. The National Institute for Occupational Safety and Health Recommended Exposure Limits (NIOSH-REL) Compendium of Policy and Statements. NIOSH, Cincinnati, OH (1992). NIOSH is the federal agency designated to conduct research relative to occupational safety and health. As is the case with ACGIH TLVs, NIOSH RELs are for guideline purposes only and as such are not legal, regulatory limits for compliance purposes.
4. The "Immediately Dangerous to Life or Health air concentration values (IDLHs)" are used by NIOSH as part of the respirator selection criteria and were first developed in the mid-1970's by NIOSH. The Documentation for Immediately Dangerous to Life or Health Concentrations (IDLHs) is a compilation of the rationale and sources of information used by NIOSH during the original determination of 387 IDLHs and their subsequent review and revision in 1994.
5. PNOR (Particulates Not Otherwise Regulated). All inert or nuisance dusts, whether mineral, inorganic, or organic, not listed specifically by substance name are covered by a limit which is the same as the inert or nuisance dust limit of 15 mg/m^3 for total dust and 5 mg/m^3 for the respirable fraction.
6. Inhalable fraction. The concentration of inhalable particulate for the application of this TLV is to be determined from the fraction passing a size-selector with the characteristics defined in the ACGIH 2013 TLVs ® and BEIs® (Biological Exposure Indices) Appendix D, paragraph A.
7. Respirable fraction. The concentration of respirable dust for the application of this limit is to be determined from the fraction passing a size-selector with the characteristics defined in ACGIH 2013 TLVs ® and BEIs ® Appendix D, paragraph C

8(b) Appropriate Engineering Controls: Use controls as appropriate to minimize exposure to metal fumes and dusts during handling operations. Provide general or local exhaust ventilation systems to minimize airborne concentrations. Local exhaust is necessary for use in enclosed or confined spaces. Provide sufficient general/local exhaust ventilation in pattern/volume to control inhalation exposures below current exposure limits.

Section 8 - Exposure Controls / Personal Protection (continued)

8(c) Individual Protection Measures:

- **Respiratory Protection:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, use only a NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. Concentration in air of the various contaminants determines the extent of respiratory protection needed. Half-face, negative-pressure, air-purifying respirator equipped with P100 filter is acceptable for concentrations up to 10 times the exposure limit. Full-face, negative-pressure, air-purifying respirator equipped with P100 filter is acceptable for concentrations up to 50 times the exposure limit. Protection by air-purifying negative-pressure and powered air respirators is limited. Use a positive-pressure-demand, full-face, supplied air respirator or self-contained breathing apparatus (SCBA) for concentrations above 50 times the exposure limit. If exposure is above the IDLH (Immediately Dangerous to Life or Health) for any of the constituents, or there is a possibility of an uncontrolled release or exposure levels are unknown, then use a positive-demand, full-face, supplied air respirator with escape bottle or SCBA.

  Warning! Air-purifying respirators both negative-pressure, and powered-air do not protect workers in oxygen-deficient atmospheres.
- **Eyes**: Wear appropriate eye protection to prevent eye contact. For operations, which result in elevating the temperature of the product to or above its melting point or result in the generation of airborne particulates, use safety glasses to prevent eye contact. Contact lenses should not be worn where industrial exposures to this material are likely. Use safety glasses or goggles as required for welding, burning, sawing, brazing, grinding or machining operations.
- **Skin**: Wear appropriate personal protective clothing to prevent skin contact. Cut resistant gloves and sleeves should be worn when working with steel products. For operations, which result in elevating the temperature of the product to or above its melting point or result in the generation of airborne particulates, use protective clothing, and gloves to prevent skin contact. Protective gloves should be worn as required for welding, burning or handling operations. Contaminated work clothing must not be allowed out of the workplace.
- **Other Protective Equipment**: An eyewash fountain and deluge shower should be readily available in the work area.

Section 9 - Physical and Chemical Properties

9(a) Appearance (physical state, color, etc.): Metallic Gray

9(b) Odor: Odorless

9(c) Odor Threshold: NA

9(d) pH: NA

9(e) Melting Point/Freezing Point: ~ 2750 ºF (~ 1510 °C)

9(f) Initial Boiling Point and Boiling Range: ND

9(g) Flash Point: NA

9(h) Evaporation Rate: NA

9(i) Flammability (solid, gas): Non-flammable, non-combustible

9(j) Upper/lower Flammability or Explosive Limits: NA

9(k) Vapor Pressure: NA

9(l) Vapor Density (Air = 1): NA

9(m) Relative Density: 7.85 g/cc

9(n) Solubility(ies): Insoluble

9(o) Partition Coefficient n-octanol/water: ND

9(p) Auto-ignition Temperature: NA

9(q) Decomposition Temperature: ND

9(r) Viscosity: NA

NA - Not Applicable

ND - Not Determined for product as a whole

Section 10 - Stability and Reactivity

10(a) Reactivity: Not Determined (ND)

10(b) Chemical Stability: Steel products are stable under normal storage and handling conditions.

10(c) Possibility of Hazardous Reaction: None Known

10(d) Conditions to Avoid: Storage with strong acids or calcium hypochlorite.

10(e) Incompatible Materials: Will react with strong acids to form hydrogen. Iron oxide dusts in contact with calcium hypochlorite evolve oxygen and may cause an explosion.

10(f) Hazardous Decomposition Products: Thermal oxidative decomposition of steel products can produce fumes containing oxides of iron and manganese as well as other alloying elements.

Section 11 - Toxicological Information

11(a-e) Information on Toxicological Effects: The following toxicity data has been determined for **Standard Pipe** as a mixture when further processed using the information available for its components applied to the guidance on the preparation of an SDS under the GHS requirements of OSHA and the EU CPL:

Hazard Classification	Hazard Category		Hazard Symbols	Signal Word	Hazard Statement
	EU	OSHA			
Acute Toxicity Hazard (covers Categories 1-5)	NA*	4[a]		**Warning**	Harmful if swallowed.
Eye Damage/ Irritation (covers Categories 1, 2A and 2B)	NA*	2B[c]	No Pictogram	**Warning**	Causes eye irritation.

Section 11 - Toxicological Information (continued)

11(a-e) Information on Toxicological Effects (continued)

Hazard Classification	Hazard Category		Hazard Symbols	Signal Word	Hazard Statement
	EU	OSHA			
Skin/Dermal Sensitization (covers Category 1)	NA*	1[d]		**Warning**	May cause an allergic skin reaction.
Carcinogenicity (covers Categories 1A, 1B and 2)	NA*	2[g]		**Warning**	Suspected of causing cancer.
Toxic to Reproduction (covers Categories 1A, 1B and 2)	NA*	2[h]		**Warning**	Suspected of damaging fertility or the unborn child.
Specific Target Organ Toxicity (STOT) Following Single Exposure (covers Categories 1-3)	NA*	3[i]		**Warning**	May cause respiratory irritation.
STOT following Repeated Exposure (covers Categories 1 and 2)	NA*	1[j]		**Danger**	Causes damage to lungs through prolonged or repeated inhalation exposure.

* Not Applicable

Toxicological data listed below are presented regardless to classification criteria. Individual hazard classification categories where the toxicological information has met or exceeded a classification criteria threshold are listed above.

a. No LC_{50} or LD_{50} has been established for **Standard Pipe**. The following data has been determined for the components:

- **Iron:** Rat LD_{50} =98.6 g/kg (REACH)
  Rat LD_{50} =1060 mg/kg (IUCLID)
  Rat LD_{50} =984 mg/kg (IUCLID)
  Rabbit LD_{50} =890 mg/kg (IUCLID)
  Guinea Pig LD_{50} =20 g/kg (TOXNET)
  Human LD_{LO} =77 g/kg (IUCLID)
- **Copper:** Rat LD_{50} = 481 mg/kg (REACH
  Rat LD_{50} > 2500 mg/kg (REACH)
- **Nickel:** LD_{50} >9000 mg/kg (Oral/Rat); NOAEC >10.2 mg/l(Inhalation/Rat)
- **Silicon:** LD_{50} = 3160 mg/kg (Oral/Rat)
- **Manganese:** Rat LD_{50} > 2000 mg/kg (REACH)
  Rat LD_{50} > 9000 mg/kg (NLM Toxnet)

b. No Skin (Dermal) Irritation data available for **Standard Pipe** as a mixture. The following Skin (Dermal) Irritation information was found for the components:

- **Molybdenum:** May cause skin irritation.

c. No Eye Irritation data available for **Standard Pipe** as a mixture. The following Eye Irritation information was found for the components:

- **Iron and Molybdenum:** Causes eye irritation.
- **Silicon:** Slight eye irritation in rabbit protocol.
- **Nickel:** Slight eye irritation from particulate abrasion only.

d. No Skin (Dermal) Sensitization data available for **Standard Pipe** as a mixture. The following Skin (Dermal) Sensitization information was found for the components:

- **Nickel:** May cause allergic skin sensitization.

e. No Respiratory Sensitization data available for **Standard Pipe** as a mixture or its components.

f. No Germ Cell Mutagenicity data available for **Standard Pipe** as a mixture. The following Mutagenicity and Genotoxicity information was found for the components:

- **Iron:** IUCLID has found some positive and negative findings in vitro.
- **Nickel:** EU RAR has found positive results in vitro and in vivo but insufficient data for classification.

g. Carcinogenicity: IARC, NTP, and OSHA do not list **Standard Pipe** as carcinogens. The following Carcinogenicity information was found for the components:

- **Welding Fumes -** IARC Group 2B carcinogen, a mixture that is possibly carcinogenic to humans.
- **Chromium (as metal and trivalent chromium compounds)** – IARC Group 3 carcinogens, not classifiable as to their human carcinogenicity.
- **Nickel and certain nickel compounds –** Group 2B - metallic nickel Group 1 - nickel compounds ACGIH confirmed human carcinogen. Nickel – EURAR Insufficient evidence to conclude carcinogenic potential in animals or humans; suspect carcinogen classification Category 2 Suspected of causing cancer.

h. No Toxic to Reproduction data available for **Standard Pipe** as a mixture. The following Toxic to Reproductive information was found for the components:

- **Nickel**: Effects on fertility.

i. No Specific Target Organ Toxicity (STOT) following a Single Exposure data available for **Standard Pipe** as a mixture. The following STOT following a Single Exposure data was found for the components:

- **Iron and Molybdenum:** Irritating to respiratory tract.

Section 11 - Toxicological Information (continued)

11(a-e) Information on Toxicological Effects (continued):

j. No Specific Target Organ Toxicity (STOT) following Repeated Exposure data was available for **Standard Pipe** as a whole. The following STOT following Repeated Exposure data was found for the components:

- **Copper:** Target organs affected - Skin, eyes liver, kidneys and respiratory tract
- **Nickel**: Rat 4 wk inhalation LOEL 4 mg/m^3 Lung and Lymph node histopathology. Rat 2 yr inhalation LOEL 0.1 mg/ m^3 Pigment in kidney, effects on hematopoiesis spleen and bone marrow and adrenal tumor. Rat 13 Week Inhalation LOAEC 1.0 mg/m^3 Lung weights, and Alveolar histopathology.
- **Manganese**: Inhalation of metal fumes - Degenerative changes in human Brain; Behavioral: Changes in motor activity and muscle weakness (Whitlock *et al.,* 1966).

The above toxicity information was determined from available scientific sources to illustrate the prevailing posture of the scientific community. The scientific resources includes: The American Conference of Governmental Industrial Hygienist (ACGIH) Documentation of the Threshold Limit Values (TLVs) and Biological Exposure Indices (BEIs) with Other Worldwide Occupational Exposure Values 2013, The International Agency for Research on Cancer (IARC), The National Toxicology Program (NTP) updated documentation, the World Health Organization (WHO) and other available resources, the International Uniform Chemical Information Database (IUCLID), European Union Risk Assessment Report (EU-RAR), Concise International Chemical Assessment Documents (CICAD), European Union Scientific Committee for Occupational Exposure Limits (EU-SCOEL), Agency for Toxic Substances and Disease Registry (ATSDR), Hazardous Substance Data Bank (HSDB), and International Programme on Chemical Safety (IPCS).

The following health hazard information is provided regardless to classification criteria and is based on the individual component(s) and potential resultant components from further processing:

Acute Effects by component:

- **Iron and Oxides:** Iron is harmful if swallowed, causes skin irritation, and causes eye irritation. Contact with iron oxide has been reported to cause skin irritation and serious eye damage.
- **Chromium, Oxides and Hexavalent Chrome:** Hexavalent chrome causes damage to gastrointestinal tract, lung, severe skin burns and eye damage, serious eye damage, skin contact may cause an allergic skin reaction. Inhalation may cause allergic or asthmatic symptoms or breathing difficulties.
- **Copper and Oxides:** Copper may cause allergic skin reaction. Copper oxide is harmful if swallowed, causes skin and eye irritation, and may cause an allergic skin reaction.
- **Manganese and Oxides:** Manganese and Manganese oxide are harmful if swallowed.
- **Molybdenum and Oxides:** Molybdenum causes skin and eye irritation. Molybdenum oxide is toxic if swallowed, and causes eye irritation.
- **Nickel and Oxides:** Nickel may cause allergic skin sensitization. Nickel oxide may cause an allergic skin.
- **Silicon and Oxides:** May be harmful if swallowed.

Delayed (chronic) Effects by Component:

- **Iron and Oxides**: Chronic inhalation of excessive concentrations of iron oxide fumes or dusts may result in the development of a benign pneumoconiosis, called siderosis, which is observable as an X-ray change. No physical impairment of lung function has been associated with siderosis. Inhalation of excessive concentrations of ferric oxide may enhance the risk of lung cancer development in workers exposed to pulmonary carcinogens. Iron oxide is listed as a Group 3 (not classifiable) carcinogen by the International Agency for Research on Cancer (IARC).
- **Chromium, Oxides and Hexavalent Chromium:** The health hazards associated with exposure to chromium are dependent upon its oxidation state. The metal form (chromium as it exists in this product) is of very low toxicity. The hexavalent form is very toxic. Repeated or prolonged exposure to hexavalent chromium compounds may cause respiratory irritation, nosebleed, ulceration and perforation of the nasal septum. Industrial exposure to certain forms of hexavalent chromium has been related to an increased incidence of cancer. NTP (The National Toxicology Program) Fourth Annual report on Carcinogens cites "certain Chromium compounds" as human carcinogens. ACGIH has reviewed the toxicity data and concluded that chromium metal is not classifiable as a human carcinogen. Hexavalent chromium may cause genetic defects and is suspected of damaging the unborn child. Developmental toxicity in the mouse, suspected of damaging fertility or the unborn child.
- **Copper and Oxides**: Inhalation of high concentrations of freshly formed oxide fumes and dusts of copper can cause metal fume fever. Chronic inhalation of copper dust has caused, in animals, hemolysis of the red blood cells, deposition of hemofuscin in the liver and pancreas, injury to lung cells and gastrointestinal symptoms.
- **Manganese and Oxides:** Chronic exposure to high concentrations of manganese fumes and dusts may adversely affect the central nervous system with symptoms including languor, sleepiness, weakness, emotional disturbances, spastic gait, mask-like facial expression and paralysis. Animal studies indicate that manganese exposure may increase susceptibility to bacterial and viral infections. Occupational overexposure (Manganese) is a progressive, disabling neurological syndrome that typically begins with relatively mild symptoms and evolves to include altered gait, fine tremor, and sometimes, psychiatric disturbances. May cause damage to lungs with repeated or prolonged exposure. Neurobehavioral alterations in worker populations exposed to MnO including: speed and coordination of motor function are especially impaired.
- **Molybdenum and Oxides:** Certain handling operations, such as burning and welding, may generate both insoluble molybdenum compounds (metal and molybdenum dioxide) and soluble molybdenum compounds (molybdenum trioxide). Molybdenum compounds generally exhibit a low order of toxicity with the trioxide the more toxic. However, some reports indicate that the dust of the molybdenum metal, molybdenum dioxide and molybdenum trioxide may cause eye, skin, nose and throat irritation in animals. Also has been reported to cause induction of tumors in experimental animals, suspected of causing cancer. Molybdenum oxide is suspected of causing cancer in humans.
- **Nickel and Oxides:** Exposure to nickel dusts and fumes can cause sensitization dermatitis, respiratory irritation, asthma, pulmonary fibrosis, edema, and may cause nasal or lung cancer in humans. Causes damage to lungs through prolonged or repeated inhalation exposure. IARC lists nickel and certain nickel compounds as Group 2B carcinogens (sufficient animal data). ACGIH 2013 TLVs® and BEIs® lists insoluble nickel compounds as confirmed human carcinogens. Suspected of damaging the unborn child.
- **Silicon and Oxides:** Silicon dusts are a low health risk by inhalation and should be treated as a nuisance dust. Eye contact with pure material can cause particulate irritation. Skin contact with silicon dusts may cause physical abrasion.

Section 12 - Ecological Information

12(a) Ecotoxicity (aquatic & terrestrial): No Data Available for **Standard Pipe** as sold/shipped. However, individual components of the product when processed have been found to be toxic to the environment. Metal dusts may migrate into soil and groundwater and be ingested by wildlife as follows:

- **Iron Oxide**: LC_{50}: >1000 mg/L; Fish 48 h-EC_{50} > 100 mg/L (Currenta, 2008k); 96 h-$LC_0 \geq$ 50,000 mg/L. Test substance: Bayferrox 130 red (95 – 97% Fe_2O_3; < 4% SiO_2 and Al_2O_3) (Bayer, 1989a).
- **Hexavalent Chrome:** EU RAR listed as category 1, found acute EC_{50} and LD_{50} to algae and invertebrates < 1 mg.
- **Nickel Oxide:** IUCLID found LC_{50} in fish, invertebrates and algae > 100 mg/l.

12(b) Persistence & Degradability: No Data Available

12(c) Bioaccumulative Potential: No Data Available

12(d) Mobility (in soil): No data available for this product as sold/shipped. However, individual components of the product have been found to be absorbed by plants from soil.

12(e) Other Adverse Effects: None Known

Additional Information:

Hazard Category: Not Reported **Signal Word:** No Signal Word

Hazard Symbol: No Symbol

Hazard Statement: No Statement

Section 13 - Disposal Considerations

Disposal: Standard Pipe should be recycled whenever possible. Product dusts and fumes from processing operations should also be recycled, or classified by a competent environmental professional and disposed of in accordance with applicable federal, state or local regulations.

Container Cleaning and Disposal: Follow applicable federal, state and local regulations. Observe safe handling precautions. European Waste Catalogue (EWC): 16-01-17 (ferrous metals), 12-01-99 (wastes not otherwise specified), 16-03 (off specification batches and unused products), or 15-01-04 (metallic packaging).

Please note this information is for Standard Pipe in its original form. Any alterations can void this information.

Section 14 - Transport Information

14 (a-g) Transportation Information:

US Department of Transportation (DOT) under 49 CFR 172.101 **does not** regulate **Standard Pipe** as a hazardous material. All federal, state, and local laws and regulations that apply to the transport of this type of material must be adhered to.

Shipping Name: Not Applicable (NA) **Shipping Symbols:** NA **Hazard Class:** NA **UN No.:** NA **Packing Group:** NA **DOT/ IMO Label:** NA **Special Provisions (172.102):** NA	**Packaging Authorizations** **a) Exceptions:** NA **b) Group:** NA **c) Authorization:** NA	**Quantity Limitations** **a) Passenger, Aircraft, or Railcar:** NA **b) Cargo Aircraft Only:** NA **Vessel Stowage Requirements** **a) Vessel Stowage:** NA **b) Other:** NA **DOT Reportable Quantities**: NA

International Maritime Dangerous Goods (IMDG) and the Regulations Concerning the International Carriage of Dangerous Goods by Rail (RID) classification, packaging and shipping requirements follow the US DOT Hazardous Materials Regulation.

Regulations Concerning the International Carriage of Dangerous Goods by Road (ADR) does not regulate **Standard Pipe** as a hazardous material.

Shipping Name: Not Applicable (NA) **Classification Code:** NA **UN No.:** NA **Packing Group:** NA **ADR Label:** NA **Special Provisions:** NA **Limited Quantities:** NA	**Packaging** **a) Packing Instructions:** NA **b) Special Packing Provisions:** NA **c) Mixed Packing Provisions:** NA	**Portable Tanks & Bulk Containers** **a) Instructions:** NA **b) Special Provisions:** NA

International Air Transport Association (IATA) does not regulate **Standard Pipe** as a hazardous material.

Shipping Name: Not Applicable (NA) **Class/Division:** NA **Hazard Label (s):** NA **UN No.:** NA **Packing Group:** NA **Excepted Quantities (EQ):** NA	**Passenger & Cargo Aircraft** **Limited Quantity (EQ)** **Pkg Inst:** NA **Max Net Qty/Pkg:** NA	**Pkg Inst:** NA **Max Net Qty/Pkg:** NA	**Cargo Aircraft Only:** **Pkg Inst:** NA **Max Net Qty/Pkg:** NA	**Special Provisions:** NA **ERG Code:** NA

Pkg Inst – Packing Instructions Max Net Qty/Pkg – Maximum Net Quantity per Package ERG – Emergency Response Drill Code

Transport Dangerous Goods (TDG) Classification: Standard Pipe does not have a TDG classification.

Section 15 - Regulatory Information

Regulatory Information: *The following listing of regulations relating to a U. S. Steel product may not be complete and should not be solely relied upon for all regulatory compliance responsibilities.* This product and/or its constituents are subject to the following regulations:

SARA Potential Hazard Categories: Immediate Acute Health Hazard; Delayed Chronic Health Hazard.

Section 313 Supplier Notification: The product, **Standard Pipe** contains the following toxic chemicals subject to the reporting requirements of section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR part 372:

CAS #	Chemical Name	Percent by Weight
7440-47-3	Chromium	2.0 max
7440-50-8	Copper	1.0 max
7439-96-5	Manganese	2.5 max
7440-02-0	Nickel	1.0 max

State Regulations: The product, **Standard Pipe** as a whole is not listed in any state regulations. However, individual components of the product are listed in various state regulations:

California Prop. 65: Contains elements known to the State of California to cause cancer or reproductive toxicity. This includes chromium compounds and nickel.

Other Regulations:

WHMIS Classification (Canadian): The product, **Standard Pipe** is not listed as a whole. However individual components are listed.

Ingredients	WHMIS Classification
Copper	D2B, B4
Manganese	B4, D2A
Molybdenum	B4, D2B
Nickel	D2B
Silicon	B4

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the SDS contains all the information required by the Controlled Products Regulations.

Section 16 - Other Information

Prepared By: United States Steel Corporation

Revision History: **Expiration Date: 4/01/17**

4/01/2014 - Update to OSHA HAZ COM 2012

12/16/10 – Combined the following three SDS's to create one that covers all three of these products:

Update of content and format to comply with GHS:

IHS Number	Product Name	USS Code	SRP Number
28456	Standard Pipe – Alloy Steel	4A018	
8182	Standard Pipe – Carbon Steel	4C018	
28458	Standard Pipe – HSLA Steel	4H018	

Additional Information:

Hazardous Material Identification System (HMIS) Classification

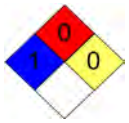
Health Hazard	1
Fire Hazard	0
Physical Hazard	0

HEALTH= **1**, * Denotes possible chronic hazard if airborne dusts or fumes are generated Irritation or minor reversible injury possible.

FIRE= **0**, Materials that will not burn.

PHYSICAL HAZARD= **0**, Materials that are normally stable, even under fire conditions, and will not react with water, polymerize, decompose, condense, or self-react. Non-explosives.

National Fire Protection Association (NFPA)



HEALTH = **1**, Exposure could cause irritation but only minor residual injury even if no treatment is given.

FIRE = **0,** Materials that will not burn.

INSTABILITY = **0**, Normally stable, even under fire exposure conditions, and are not reactive with water.

ABBREVIATIONS/ACRONYMS:

ACGIH	American Conference of Governmental Industrial Hygienists	**NIF**	No Information Found
BEIs	Biological Exposure Indices	**NIOSH**	National Institute for Occupational Safety and Health
CAS	Chemical Abstracts Service	**NTP**	National Toxicology Program
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act	**ORC**	Organization Resources Counselors
CFR	Code of Federal Regulations	**OSHA**	Occupational Safety and Health Administration
CNS	Central Nervous System	**PEL**	Permissible Exposure Limit
GI, GIT	Gastro-Intestinal, Gastro-Intestinal Tract	**PNOR**	Particulate Not Otherwise Regulated
HMIS	Hazardous Materials Identification System	**PNOC**	Particulate Not Otherwise Classified

Section 16 - Other Information (continued)

ABBREVIATIONS/ACRONYMS (continued):

IARC	International Agency for Research on Cancer		**PPE**	Personal Protective Equipment
LC50	Median Lethal Concentration		**ppm**	parts per million
LD50	Median Lethal Dose		**RCRA**	Resource Conservation and Recovery Act
LD_{Lo}	Lowest Dose to have killed animals or humans		**RTECS**	Registry of Toxic Effects of Chemical Substances
LEL	Lower Explosive Limit		**SARA**	Superfund Amendment and Reauthorization Act
LOEL	Lowest Observed Effect Level		**SCBA**	Self-contained Breathing Apparatus
LOAEC	Lowest Observable Adverse Effect Concentration		**SDS**	Safety Data Sheet
µg/m^3	microgram per cubic meter of air		**STEL**	Short-term Exposure Limit
mg/m^3	milligram per cubic meter of air		**TLV**	Threshold Limit Value
mppcf	million particles per cubic foot		**TWA**	Time-weighted Average
MSHA	Mine Safety and Health Administration		**UEL**	Upper Explosive Limit
NFPA	National Fire Protection Association			

Disclaimer: This information is taken from sources or based upon data believed to be reliable. However, United States Steel Corporation makes no warranty as to the absolute correctness or sufficiency of any of the foregoing or that additional or other measures may not be required under particular conditions.

APPENDIX E POTENTIAL ECOTOXICITY EVALUATION

Additive	Constituent Percentage in Additive[1]	Pounds of Additive Used on 4/28/2020	Bore Hole Concentration (lbs/gal)	Bore Hole Concentration (mg/L)	Toxicity (mg/L)	Test Organism	Safety Data Sheet Source
Super Gel-X	**195 bags (50 lbs each)**	**9750 lbs**					
Trade Secret	0.10%	9.75E+00	1.46E-03	1.74E+02	4.7E+01 (EC_{50} at 48 hrs)	*Daphnia*	CETCO 2015
Other components - bentonite	90-100%	9.75E+03	1.46E+00	9.00E-01[3]	2.48E+01 (EC_{50} at 48 hrs)	Coon stripe shrimp (*Pandalus danae*)	CETCO 2015
Quartz	8%	7.80E+02	1.16E-01	1.39E+04	-	-	CETCO 2015
Cristobalite	2%	1.95E+02	2.91E-02	3.49E+03	-	-	CETCO 2015
Platinum D-D	**0.5 gal**	**0.06 lbs[2]**					
Water	60-100%	6.00E-02	8.95E-06	1.07E+00	-	-	MiSwACO 2015
Sodium dodecylbenzenesulfonate	1-5%	3.00E-01	4.47E-05	5.36E+00	1.08E+01 (LC_{50} at 96 hrs)	*Oncorhynchus mykiss*	MiSwACO 2015
Tetrapotassium diphosphate	1-5%	3.00E-01	4.47E-05	5.36E+00	1.00E+02 (LC_{50} at 96 hrs)	*Oncorhynchus mykiss*	MiSwACO 2015
Alcohols, C10-16, ethoxylated, sulfates, sodium salts	1-5%	3.00E-01	4.47E-05	5.36E+00	-	-	MiSwACO 2015
Wyo-Vis DP	**4 lbs**						
Water soluble polymer	100%	4.00E+00	5.97E-04	7.15E+01	1.00E+02 (LC_{50} at 96 hrs)	*Oncorhynchus mykiss*	Wyo-Ben, Inc. 2015
Sand Force	**4 lbs**						
Xanthan gum	60-100%	4.00E+00	5.97E-04	7.15E+01	3.20E+02 (LC_{50} at 96 hrs)	*Oncorhynchus mykiss*	Right Turn Supply 2018
Soda Ash	**4 lbs**						
Sodium carbonate	99.80%	3.99E+00	5.96E-04	7.14E+01	2.65E+02 (LC_{50} at 96 hrs)	*Daphnia magna*	Right Turn Supply 2015

Footnotes:

- = No ecotoxicity information was available for this constituent.

[1] = Percentage of the additive constituent used to determine concentration in the bore hole was the highest possible percentage given in the SDS.

[2] = It was assumed that the weight of Platinum D-D is equivelent to water. Therefore, 1 gal was equal to 8.34 lbs.

[3] = Bentonite is described as almost insoluble in water in CETCO 2015. Therefore, the solubility concentration was used as the maximum possible concentration of bentonite in the drilling fluid for this assessment.

Abbreviations:

EC_{50} = Concentration which induces a response halfway between the baseline response and the maximum response.

gal = Gallon

L = Liter

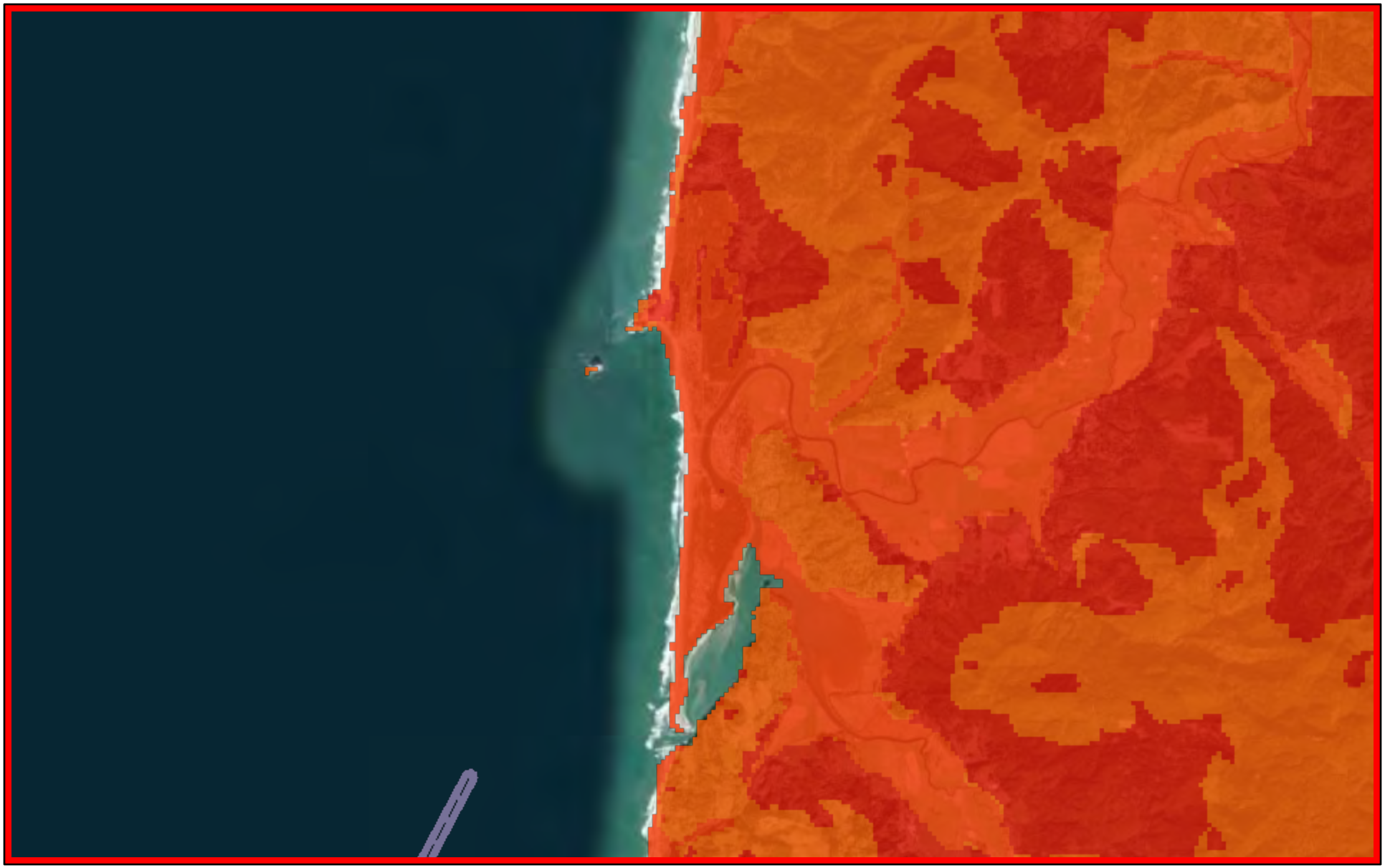
lbs = Pound

LC_{50} = Lethal concentration that kills 50 percent of the test organisms during the observation period.

mg = Milligram

APPENDIX F GEOLOGIC FIGURES

Oregon Coastal Earthquake Risk



August 24, 2020

Cascadia Earthquake Expected Shaking

- Violent
- Severe
- Very Strong
- Strong
- Moderate
- Light
- Active Faults

Expected Earthquake Shaking

- Violent
- Severe

1:120,000

0 0.75 1.5 3 mi

0 1 2 4 km

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS,

Landslide Risk 1 to 24K

August 24, 2020

Landslide Hazard

Red: Band_1

Green: Band_2

Blue: Band_3

1:24,000

0 0.13 0.25 0.5 mi

0 0.23 0.45 0.9 km

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS,

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
www.OregonGeology.org
Larry Givens, Governing Board Chair
Vicki S. McConnell, Director and State Geologist
Don W.T. Lewis, Assistant Director
Rachel R. Lyles Smith, Project Operations Manager
Ian P. Madin, Chief Scientist

Local Source (Cascadia Subduction Zone) Tsunami Inundation Map
Sand Lake, Oregon

2012

Tsunami Inundation Map Till-11

Tsunami Inundation Maps for Sand Lake, Tillamook County, Oregon

Plate 1

Introduction

The Oregon Department of Geology and Mineral Industries (DOGAMI) has been identifying and mapping the tsunami inundation hazard along the Oregon coast since 1994. In Oregon, DOGAMI manages the National Tsunami Hazard Mitigation Program, which has been administered by the National Oceanic and Atmospheric Administration (NOAA) since 1995. DOGAMI's work is designed to help cities, counties, and other sites in coastal areas reduce the potential for disastrous tsunami-related consequences by understanding and mitigating this geologic hazard. Using federal funding awarded by NOAA, DOGAMI has developed a new generation of tsunami inundation maps to help residents and visitors along the entire Oregon coast prepare for the next Cascadia Subduction Zone (CSZ) earthquake and tsunami.

The CSZ is the tectonic plate boundary between the North American Plate and the Juan de Fuca Plate (Figure 1). These plates are converging at a rate of about 1.5 inches per year, but the movement is not smooth and continuous. Rather, the plates lock in place, and unreleased energy builds over time. At intervals, this accumulated energy is violently released in the form of a megathrust earthquake rupture, where the North American Plate suddenly slips westward over the Juan de Fuca Plate. This rupture causes a vertical displacement of water that creates a tsunami (Figure 2). Similar rupture processes and tsunamis have occurred elsewhere on the planet where subduction zones exist: for example, offshore Chile in 1960 and 2010, offshore Alaska in 1964, near Sumatra in 2004, and offshore Japan in March 2011.

CSZ Frequency: Comprehensive research of the offshore geologic record indicates that at least 19 major ruptures of the full length of the CSZ have occurred off the Oregon coast over the past 10,000 years (Figure 3). All 19 of these full-rupture CSZ events were likely magnitude 8.9 to 9.2 earthquakes (Witter and others, 2011). The most recent CSZ event happened approximately 300 years ago on January 26, 1700. Sand deposits carried onshore and left by the 1700 event have been found 1.2 miles inland; older tsunami sand deposits have also been discovered in estuaries 6 miles inland. As shown in Figure 3, the range in time between these 19 events varies from 110 to 1,150 years, with a median time interval of 490 years. In 2008 the United States Geological Survey (USGS) released the results of a study announcing that the probability of a magnitude 8-9 CSZ earthquake occurring over the next 30 years is 10% and that such earthquakes occur about every 500 years (WGCEP, 2008).

CSZ Model Specifications: The sizes of the earthquake and its resultant tsunami are primarily driven by the amount and geometry of the slip that takes place when the North American Plate snaps westward over the Juan de Fuca Plate during a CSZ event. DOGAMI has modeled a wide range of earthquake and tsunami sizes that take into account different fault geometries that could amplify the amount of seawater displacement and increase tsunami inundation. Seismic geophysical profiles show that there may be a steep splay fault running nearly parallel to the CSZ but closer to the Oregon coastline (Figure 1). The effect of this splay fault moving during a full-rupture CSZ event would be an increase in the amount of vertical displacement of the Pacific Ocean, resulting in an increase of the tsunami inundation onshore in Oregon. DOGAMI has also incorporated physical evidence that suggests that portions of the coast may drop 4 to 10 feet during the earthquake; this effect is known as subsidence. Detailed information on fault geometries, subsidence, computer models, and the methodology used to create the tsunami scenarios presented on this map can be found in DOGAMI Special Papers 41 (Priest and others, 2009) and 43 (Witter and others, 2011).

Map Explanation

This tsunami inundation map displays the output of computer models representing five selected tsunami scenarios, all of which include the earthquake-produced subsidence and the tsunami-amplifying effects of the splay fault. Each scenario assumes that a tsunami occurs at Mean Higher High Water (MHHW) tide; MHHW is defined as the average height of the higher high tides observed over an 18-year period at the Garibaldi tide gauge. To make it easier to understand this scientific material and to enhance the educational aspects of hazard mitigation and response, the five scenarios are labeled as "T-shirt sizes" ranging from Small, Medium, Large, Extra Large, to Extra Extra Large (S, M, L, XL, XXL). The map legend depicts the respective amounts of slip, the frequency of occurrence, and the earthquake magnitude for these five scenarios. Figure 4 shows the cumulative number of buildings inundated within the map area.

The computer simulation model output is provided to DOGAMI as millions of points with values that indicate whether the location of each point is wet or dry. These points are converted to wet and dry contour lines that form the extent of inundation. The transition area between the wet and dry contour lines is termed the Wet/Dry Zone, which equates to the amount of error in the model when determining the maximum inundation for the each scenario. Only the XXL Wet/Dry Zone is shown on this map.

This map also shows the regulatory tsunami inundation line (Oregon Revised Statutes 455.446 and 455.447), commonly known as the Senate Bill 379 line. Senate Bill 379 (1995) instructed DOGAMI to establish the area of expected tsunami inundation based on scientific evidence and tsunami modeling in order to prohibit the construction of new essential and special occupancy structures in this tsunami inundation zone (Priest, 1995).

Time Series Graphs and Wave Elevation Profiles: In addition to the tsunami scenarios, the computer model produces time series data for "gauge" locations in the area. These points are simulated gauge stations that record the time, in seconds, of the tsunami wave arrival and the wave height observed. It is especially noteworthy that the greatest wave height and velocity observed are not necessarily associated with the first tsunami wave to arrive onshore. Therefore evacuees should not assume that the tsunami event is over until the proper authorities have sounded the all-clear signal at the end of the evacuation. Figure 5 depicts the tsunami waves as they arrive at a simulated gauge station. Figure 6 depicts the overall wave height and inundation extent for all five scenarios at the profile locations shown on this map.

Cascadia Subduction Zone Setting

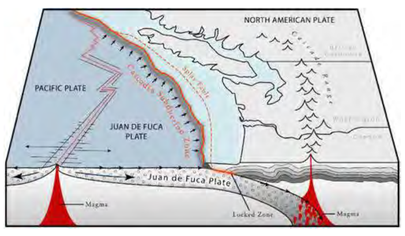


Figure 1: This block diagram depicts the tectonic setting of the region. See Figure 2 for the sequence of events that occur during a Cascadia Subduction Zone megathrust earthquake and tsunami.

How Tsunamis Occur

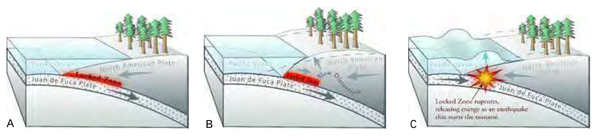
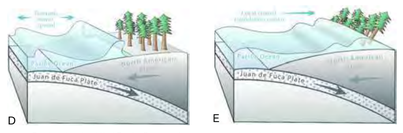


Figure 2: The North American Plate rides over the descending Juan de Fuca Plate at a rate of approximately 1.5 inches per year.

Because the two plates are stuck in place at the "locked zone," strain builds up over time and the North American Plate bulges up.

Eventually the locked zone ruptures and causes a great earthquake. The sudden slip of the two plates displaces Pacific Ocean water upward and creates a tsunami.



Displaced and uplifted Pacific Ocean water rushes in all directions.

Along the Oregon coast, tsunami waves run up onto the land for several hours.

Occurrence and Relative Size of Cascadia Subduction Zone Megathrust Earthquakes

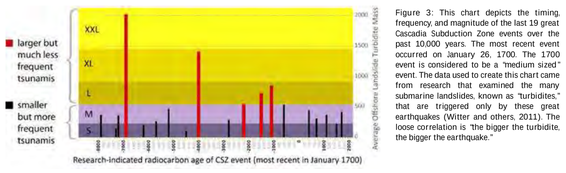


Figure 3: This chart depicts the timing, frequency, and magnitude of the last 19 great Cascadia Subduction Zone events over the past 10,000 years. The most recent event occurred on January 26, 1700. The 1700 event is considered to be a "medium sized" event. The data used to create this chart came from research that examined the many submarine landslides, known as "turbidites," that are triggered only by these great earthquakes (Witter and others, 2011). The loose correlation is "the bigger the turbidite, the bigger the earthquake."

Buildings within Tsunami Inundation Zones

	Entire Map Area	Unincorporated Areas
Total Buildings	669	669
Buildings within Tsunami Zones*		
Small	32	32
Medium	313	313
Large	396	396
Extra Large	471	471
Extra Extra Large	473	473
Percent of Buildings within Tsunami Zones		
Small	4.8%	4.8%
Medium	46.8%	46.8%
Large	59.2%	59.2%
Extra Large	70.4%	70.4%
Extra Extra Large	70.7%	70.7%

*Building counts shown are based on polygon centroids and are cumulative within the map area.

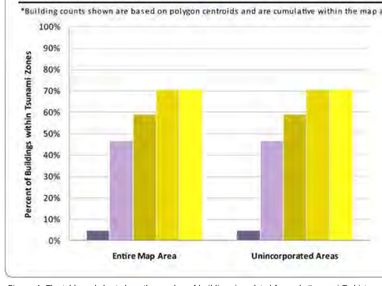


Figure 4: The table and chart show the number of buildings inundated for each "tsunami T-shirt scenario" for cities and unincorporated portions of the map.

Estimated Tsunami Wave Height through Time for Simulated Gauge Station

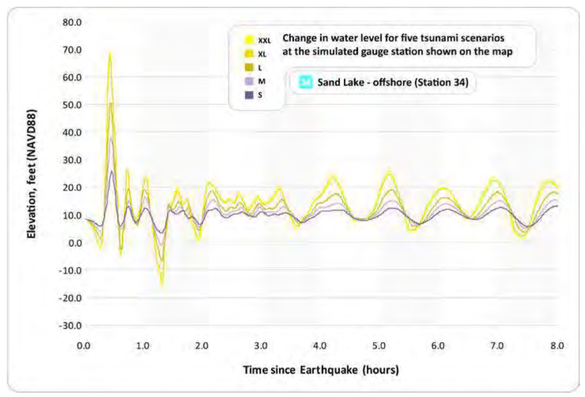


Figure 5: This chart depicts the tsunami waves as they arrive at the selected reference point (simulated gauge station). It shows the change in wave heights for all five tsunami scenarios over an 8-hour period. The starting water elevation (0.0 hour) takes into account the local land subsidence or uplift caused by the earthquake. Wave heights vary through time, and the first wave will not necessarily be the largest as waves interfere and reflect off local topography and bathymetry.

Maximum Wave Elevation Profiles

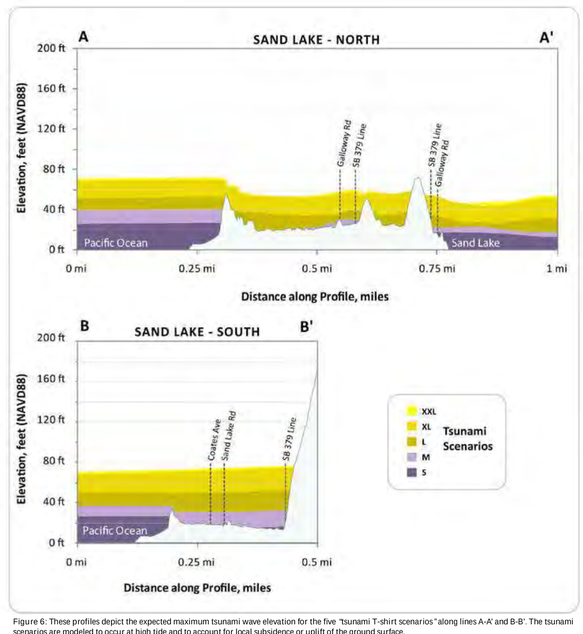


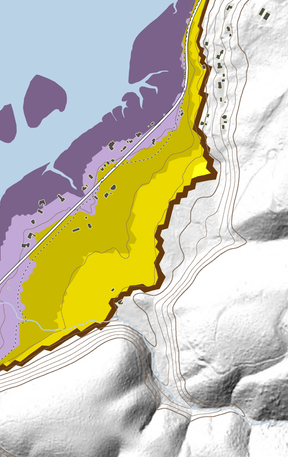
Figure 6: These profiles depict the expected maximum tsunami wave elevation for the five "tsunami T-shirt scenarios" along lines A-A' and B-B'. The tsunami scenarios are modeled to occur at high tide and to account for local subsidence or uplift of the ground surface.

Legend

Earthquake Size		Average Slip Range (ft)	Maximum Slip Range (ft)	Time to Accumulate Slip (yrs)	Earthquake Magnitude
	XXL	59 to 72	118 to 144	1,200	~9.1
	XL	56 to 72	115 to 144	1,050 to 1,200	~9.1
	L	36 to 49	72 to 98	650 to 800	~9.0
	M	23 to 30	46 to 62	425 to 525	~8.9
	S	13 to 16	30 to 36	300	~8.7
	XXL Wet/Dry Zone				

- Urban Growth Boundary
- Building Footprint
- Simulated Gauge Station (6)
- Profile Location
- Senate Bill 379 Line
- State Park
- Elevation Contour (25 ft intervals up to 200 ft)
- Fire Station
- Police Station
- School
- Hospital/Urgent Care Clinic
- U.S. Highway (101)
- State Highway (34)
- Improved Road

Tsunami Inundation Map Index



Till-01	Arch Cape - Falcon Cove	Till-08	Cape Meares
Till-02	Manzanita - Nehalem	Till-09	Netarts - Oceanside
Till-03	Nehalem East	Till-10	Cape Lookout
Till-04	Rockaway Beach	Till-11	Sand Lake
Till-05	Garibaldi - Bay City	Till-12	Pacific City
Till-06	Tillamook North	Till-13	Nestucca Bay
Till-07	Tillamook South	Till-14	Neskowin

Data References

Source Data:
This map is based on hydrodynamic tsunami modeling by Joseph Zhang, Oregon Health and Science University, Portland, Oregon.
Model data input were created by John T. English and George R. Priest, Department of Geology and Mineral Industries (DOGAMI), Portland, Oregon.

Hydrology data, contours, critical facilities, and building footprints were created by DOGAMI. Senate Bill 379 line data were redigitized by Rachel R. Lyles Smith and Sean G. Pickner, DOGAMI, in 2011 (GIS file set, in press, 2012).

Urban growth boundaries (2010) were provided by the Oregon Department of Land Conservation and Development (DLCD).

Transportation data (2011) provided by Tillamook County were edited by DOGAMI to improve the spatial accuracy of the features or to add newly constructed roads not present in the original data layer.

Lidar data are from DOGAMI Lidar Data Quadrangles LDQ-2011-45123-B8-NestuccaBay and LDQ-2011-45123-C8-SandLake.

Coordinate System: Oregon Statewide Lambert Conformal Conic, Unit: International Feet, Horizontal Datum: NAD 1983 HARN, Vertical Datum: NAVD 1988. Graticule shown with geographic coordinates (latitude/longitude).

References:
2007 Working Group on California Earthquake Probabilities (WGCEP), 2008, The Uniform California Earthquake Rupture Forecast, Version 2 (UCERF 2): U.S. Geological Survey Open-File Report 2007-1437 and California Geological Survey Special Report 203 [http://pubs.usgs.gov/of/2007/1437/].

Priest, G. R., 1995, Explanation of mapping methods and use of the tsunami hazard maps of the Oregon coast, Oregon Department of Geology and Mineral Industries Open-File Report O-95-67, 95 p.

Priest, G.R., Goldfinger, C., Wang, K., Witter, R.C., Zhang, Y., and Baptista, A.M., 2009, Tsunami hazard assessment of the northern Oregon coast: a multi-deterministic approach tested at Cannon Beach, Clatsop County, Oregon: Oregon Department of Geology and Mineral Industries Special Paper 41, 87 p.

Witter, R.C., Zhang, Y., Wang, K., Priest, G.R., Goldfinger, C., Stimely, L.L., English, J.T., and Ferro, P.A., 2011, Simulating tsunami inundation at Bandon, Coos County, Oregon, using hypothetical Cascadia and Alaska earthquake scenarios: Oregon Department of Geology and Mineral Industries Special Paper 43, 57 p.

Software: Esri ArcGIS® 10.0, Microsoft® Excel®, and Adobe® Illustrator®

Funding: This map was funded under award #NA09NWS4670014 by the National Oceanic and Atmospheric Administration (NOAA) through the National Tsunami Hazard Mitigation Program.

Map Data Creation/Development:
Tsunami Inundation Scenarios: George R. Priest, Laura L. Stimely, Daniel E. Coe, Paul A. Ferro, Sean G. Pickner, Rachel R. Lyles Smith
Basemap Data: Kaleena L.B. Hughes, Sean G. Pickner

Map Production:
Cartography: Kaleena L.B. Hughes, Sean G. Pickner, Taylore E. Womble
Text: Don W.T. Lewis, Rachel R. Lyles Smith
Editing: Don W.T. Lewis, Rachel R. Lyles Smith
Publication: Deborah A. Schueller
Map Date: 07/12/2012

For copies of this publication contact:
Nature of the Northwest Information Center
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Portland, Oregon 97232
telephone (971) 673-2331
http://www.naturenw.org

Scale 1:10,000

0 0.25 0.5 Mile
0 0.25 0.5 1 Kilometer

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ERM's Portland Office
1050 SW 6th Ave. Suite 1650
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