Nikkiso Clean Energy & Industrial Gases Group

Your global choice for innovative equipment and solutions in liquid gases and beyond.

Cryogenic Pumps Edition

NIKKISO

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Cryogenic Pumps Edition

Nikkiso Cryogenic Industries
Clean Energy and Industrial Gases Group

Nikkiso Cryogenic Industries Clean Energy and Industrial Gases Group was created from the March 2019 consolidation of Cryogenic Industries and Nikkiso Cryo, both subsidiaries of Nikkiso Co., Ltd. Japan. Working together with our shared experience, resources and commitment to quality, will allow us to focus more closely on our customers' needs, providing individual support, service and solutions.

Vision

Leading the change to a healthier world

Mission

We provide innovative equipment, technologies and services through our global group of companies to help our customers to make a difference.

The group consists of five functional units:

Cryogenic Pumps
Aligns Nikkiso ACD's, Nikkiso Cryo's and JC Carter's lines of pumps

Cryogenic Process Systems
Incorporates turbo expanders along with LNG and Air Separation plants

Heat Exchanger Systems
Focuses on cryogenic vaporizers, LNG and industrial gas equipment

Cryogenic Services
Provides service and support through a broad network of global facilities

Fueling & Solutions
Focuses on hydrogen and natural gas fueling markets and turnkey systems

Nikkiso Energy Infrastructure & Strategic Projects (NESP)
Provides turnkey solutions for energy infrastructure including geothermal plants, compressed hydrogen distribution systems, energy recovery solutions, and offshore marine fueling systems

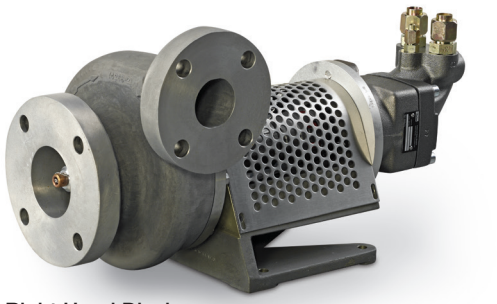
"One key benefit of our new business approach is the capacity to expand our offerings and provide a comprehensive product line for clean energy such as LNG and hydrogen, in addition to our existing line of products for industrial gases," said Peter Wagner, President and CEO of Cryogenic Industries.

Through joint research and innovation, the Group will provide increased engineering and systems solutions for market development.

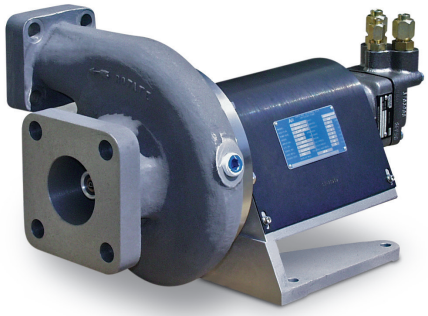
NIKKISO ACD

ACD Centrifugal Pumps

Model AC-18 (HD)
Boost Pumps/Trailer Off-Load Pumps



Right Hand Discharge
2 x 3 x 6 & 2 x 4 x 6



Left Hand Discharge
1 x 2 x 4.5 & 1.5 x 2.5 x 6

Specifications

Pump Size	units	1 x 2 x 4.5	1.5 x 2.5 x 6	2 x 3 x 6	2 x 4 x 6
Flow Range	gpm	5 – 500			
	lpm	20 – 1,900			
NPSHR	feet	3 – 35			
	meter	2 – 10			
Differential Head	feet	40 – 780			
	meter	13 – 240			
Pump Design Rating	hp	1 – 85			
	kw	0.75 – 60			
Speed Range	rpm	2,000-7,200	2,000-7,200	2,000-6,000	2,000-6,000

Consult Nikkiso ACD engineering to confirm available sizes and ratings.

Features & Benefits

- Compact design is lightweight and reduces installation time
- Hydraulic drive allows operators to use truck PTO system
- Bearing housing designed for well service, heavy duty applications
- Shaft seal features CFS design, extending seal life

Applications

- Well service
- Transfer boost pump
- Trailer off load

Typical Scope of Supply

- Pump, bearing housing and hydraulic coupling
- CFS mechanical seal
- Purge ports

Liquids Pumped

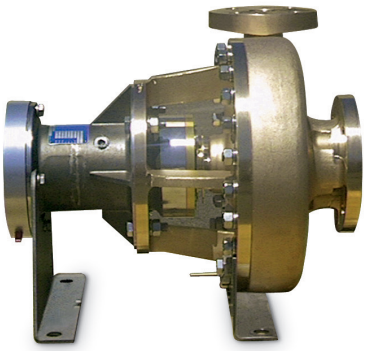
- Nitrogen
- Argon
- Methane

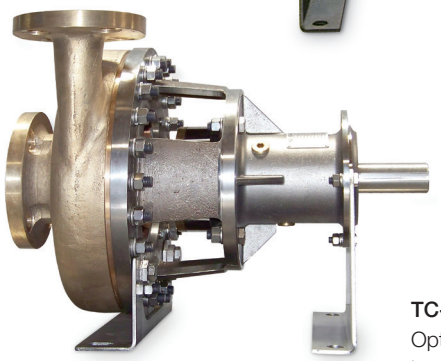
Optional Accessories

- Purge kit (bearings)
- Mating flanges

Models TC-21(HD) and (J) Trailer Pumps

TC-21 (HD)
Bronze intermediate





TC-21 (J)
Optional Stainless Steel intermediate

Specifications

Pump Size	units	1.5 x 2.5 x 10
Flow Range	gpm	25 – 225
	lpm	95 – 852
NPSHR	feet	3 – 10
	meter	1 – 3.5
Differential Head	feet	100 – 1,200
	meter	31 – 366
Speed Range	rpm	1,500 – 5,500

Consult Nikkiso ACD engineering to confirm available sizes and ratings.

Features & Benefits

- State-of-the-art CFS mechanical seal for extended life
- High performance impeller provides a high flow rate with minimum NPSH required
- Machined heavy duty stainless steel shaft provides vibration free performance
- All bronze construction allows for oxygen compatibility
- Optional stainless intermediate and backplate reduces cold migration and prevents premature bearing failure

Applications

- Trailer off loading with hydraulic (HD) or jack shaft (J) drive

Liquids Pumped

- Nitrogen
- Oxygen
- Argon
- Methane

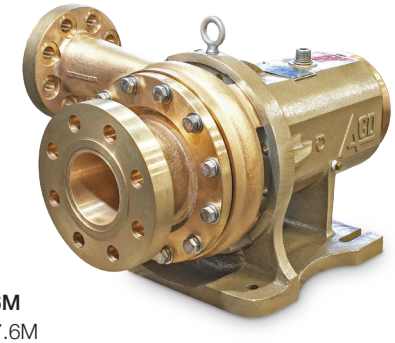
Optional Accessories

- Stainless steel intermediate and backplate
- Speed pick-up and tachometer

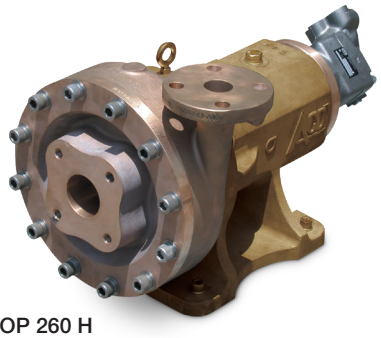
Typical Scope of Supply

- Pump and bearing housing
- SAE-B flange to accept direct hydraulic motor mounting (HD only)
- Mounting brackets with locking tabs
- Port for speed verification
- Purge port (mechanical seal)

TOP SERIES
Trailer Off-Loading Pumps



TOP 7.6M
2 x 3 x 7.6M



TOP 260 H
1.5 x 2.5 x 10

TOP 215
3 x 4 x 8.5

Specifications

Pump Size	units	TOP 7.6M 2 x 3 x 7.6M	TOP 215 3 x 4 x 8.5	TOP 260 H 1.5 x 2.5 x 10
Flow Rate	gpm	10 – 180	50 – 950	25 – 290
	lpm	40 – 680	190 – 3,600	100 – 1,100
Differential Head	feet	85 – 1,250	90 – 800	90 – 1,400
	meter	25 – 380	30 – 245	30 – 425
Maximum Working Pressure	psi	500	340	550
	bar	34	23	38
Maximum Power	hp	134	200	134
	kw	100	150	100
Speed Range	rpm	1,500 – 8,000	1,500 – 6,000	1,500 – 6,600

Consult Nikkiso ACD engineering to confirm available sizes and ratings.

Features & Benefits

- Mechanical component seal design with composite face material
- Oil-lubricated bearing housing ensures lubricity of components and improves bearing life
- Cylindrical roller bearings strengthen capacity for lateral loads
- Hydraulic or jackshaft drive

Liquids Pumped

- Nitrogen
- Oxygen
- Argon
- Methane

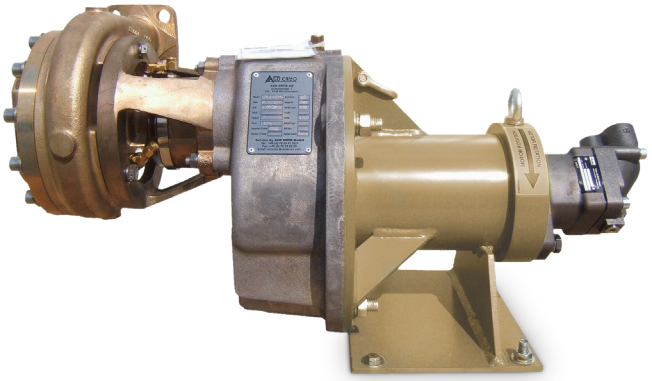
Bearing Housing

- Uses Hydrocarbon or Oxygen compatible oil
- Designed in compliance with CGA G-4.7 and EIGA/IGC 148/08/E guidelines for centrifugal oxygen pumps
- Up to 6,000 hours life—equivalent to 3 seal exchanges
- Best lubricated bearings in the industry

Component Seal Exchange

- Ease of installation reduces downtime
- Allows field exchange without removing the pump from the trailer
- Seal features composite face material
- No need to disconnect discharge piping

Model CPLH
Trailer Pumps



Specifications

Pump Size	units	
Flow Range	gpm	50 – 159
	lpm	60 – 600
NPSHR	feet	0.49 – 5.3
	meter	0.15 – 1.6
Differential Head	feet	328 – 1286
	meter	100 – 392
Pump Design Rating	hp	max 49.6
	kw	max. 37 kw
Speed Range	rpm	2950 – 8260

Consult Nikkiso ACD engineering to confirm available sizes and ratings.

Features & Benefits

- Multiple configurations and sizes accommodate lots of duties and applications
- Driven by fixed speed electric motor via an oil lubricated gearbox
- Impeller wear ring reduces maintenance and improves efficiencies
- An inducer lowers the NPSH requirement
- CFS mechanical shaft seal for long life performance
- Suits a large range of flow rates
- Intermittent use

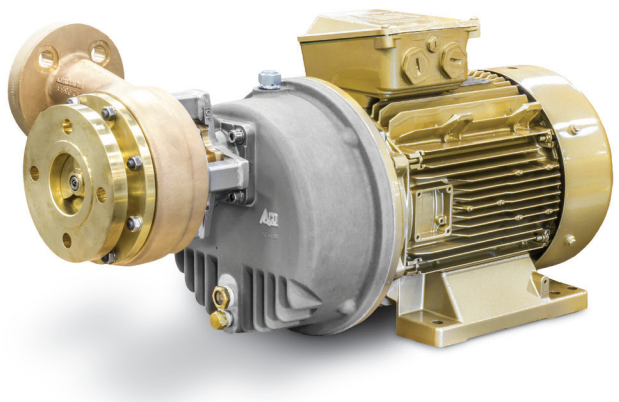
Applications

- Trailer and container loading and unloading
- Liquid storage transfer
- Process pumps

Liquids Pumped

- Nitrogen
- Oxygen
- Argon
- Methane

Model AC-14/14M
Trailer Off-Loading Pumps



1 x 2 x 4.5, 1.5 x 2.5 x 6 and 1.5 x 2.5 x 6.25M

Specifications

Pump Size	units	1.5 x 2.5 x 6.25M
Flow Range	gpm	20 – 200
	lpm	75 – 750
NPSHR	feet	1.4 – 9.0
	meter	0.42 – 2.7
Differential Head	feet	440 – 990
	meter	135 – 300
Pump Design Rating	hp	30 - 33
	kw	22.5 - 25
Speed Range	rpm	4,200 - 8,200

Consult Nikkiso ACD engineering to confirm available sizes and ratings.

Features & Benefits

- XP Inducer improves NPSH required
- Gearbox design provides:
  - Improved efficiencies at higher speeds
  - Higher operating range (flows and pressures)
  - Splash oil lube system for improved bearing life and lower maintenance requirements
  - Reduced vibration and noise
- All parts interchangeable with comparable pump
- Stainless steel bearing house reduces “cold creep” into the gearbox

Applications

- Trailer off loading
- Liquid storage transfer

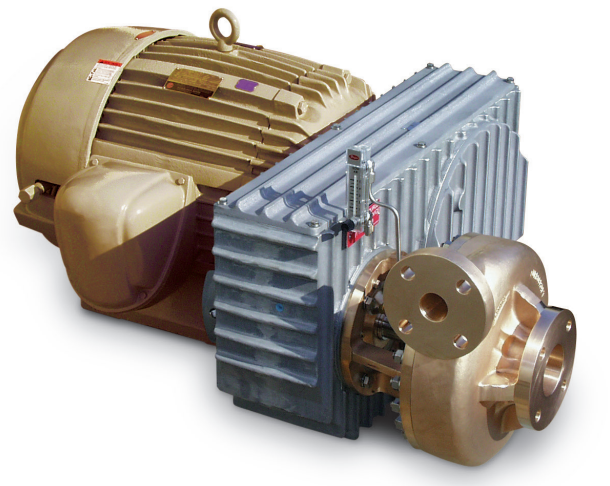
Liquids Pumped

- Nitrogen
- Oxygen
- Argon
- Methane

Typical Scope of Supply

- Pump, high performance gearbox drive and TEFC motor with purge ports
- Splash lubricated gears
- Long life (CFS) mechanical seal
- IEC Motor frame

Model AC/TC-50
Belt Box Pumps



1 x 2 x 6 - 25, 1.5 x 2.5 x 10 and 2 x 4 x 8.5

Specifications

Pump Size	units	1.5 x 2.5 x 10
Flow Range	gpm	20 – 200
	lpm	75 – 750
NPSHR	feet	2 – 12
	meter	0.6 – 4
Differential Head	feet	200 – 1,500
	meter	60 – 455
Pump Design Rating	hp	25 – 100
	kw	19 – 75
Speed Range	rpm	3,650 – 8,750

Consult Nikkiso ACD engineering to confirm available sizes and ratings.

Features & Benefits

- Rugged high speed belt box:
  - Excellent for intermittent duty, high power/flow applications
  - Design does not require an inverter duty motor to obtain high speed, high pressure applications
  - Excellent cold creep barrier to protect motor bearings
- Impeller design allows for low NPSH requirement
- All bronze construction allows for O_2 compatibility
- Mechanical seal (CFS) ensures long life
- Bearing/belt box purge ports provided for O_2 applications

Applications

- Liquid storage transfer
- Small and medium plant transfer and pipeline back-up
- Tank car unloading

Liquids Pumped

- Nitrogen
- Oxygen
- Argon
- Methane

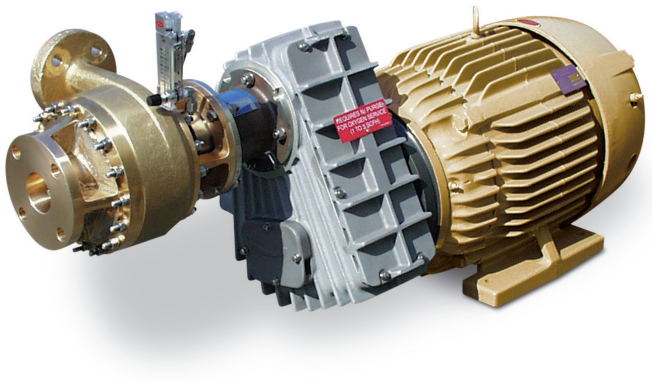
Typical Scope of Supply

- Pump, TEFC motor, and high performance belt box drive shown
- Mechanical seal purge ports

Optional Accessories

- Pump skid assembly
- Bearing purge kit
- Spare parts kit

Model AC/TC-21
Belt Box Pumps



.75 x 1 x 4, 1 x 2 x 4.5, 1 x 2 x 6, 1 x 2 x 6-25 and 1.5 x 2.5 x 6C

Specifications

Pump Size	units	1.5 x 2.5 x 6C
Flow Range	gpm	10 – 180
	lpm	35 – 680
NPSHR	feet	2 – 8
	meter	0.6 – 2.5
Differential Head	feet	100 – 1,100
	meter	30 – 335
Pump Design Rating	hp	5 – 40
	kw	3.75 – 30
Speed Range	rpm	2,000 – 10,500

Consult Nikkiso ACD engineering to confirm available sizes and ratings.

Features & Benefits

- Belt drive design allows for higher speeds
- Belt tension mechanism increases life of the timing belt and bearings
- Lightweight aluminum belt housing construction reduces overall pump weight
- Belt drive components have “full tooth engagement” for greater capacity and longer life
- Bearing purge ports are provided for liquid oxygen applications
- Cold end can be removed as a single piece, simplifying maintenance
- All bronze construction allows for O_2 compatibility

Applications

- Liquid storage transfer
- Liquid cylinder filling
- Trailer off-loading (ground mount)
- Test facility support
- Laboratory research

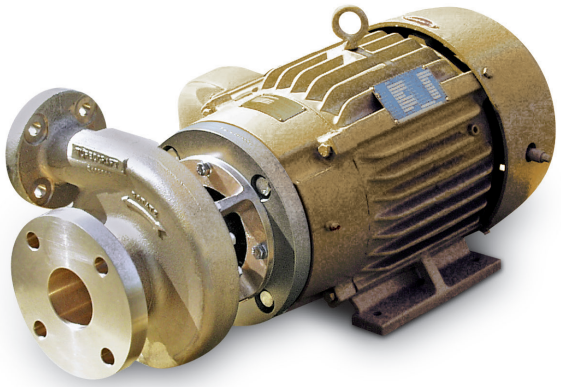
Liquids Pumped

- Nitrogen
- Oxygen
- Argon
- Methane

Typical Scope of Supply

- Pump, belt box, TEFC motor shown
- Grease packed bearings
- Motor purge ports
- Long life mechanical seal (CFS)

Model AC/TC-30
Close Coupled Pumps



Multiple sizes available

Specifications

Pump Size	units	Multiple
Flow Range	gpm	15 – 2,000
	lpm	60 – 7,570
NPSHR	feet	2 – 12
	meter	0.6 – 4
Differential Head	feet	20 – 3,000
	meter	6 – 915
Pump Design Rating	hp	3 – 400
	kw	2.2 – 300
Speed Range	rpm	1,450 – 7,200

Consult Nikkiso ACD engineering to confirm available sizes and ratings.

Features & Benefits

- Close coupled design provides:
  - Operations at high efficiencies
  - Fewer moving parts
  - Lower maintenance costs
- Shaft seal design (mechanical, gas riding or labyrinth) are state-of-the-art and prolong life without leakage
- VFD compatibility allows for multiple operating speeds
- Minimum recirculation wear rings reduce maintenance requirements and improve efficiencies

Applications

- Liquid storage transfer
- Process plant
- Truck and trailer off-loading
- Tank car unloading

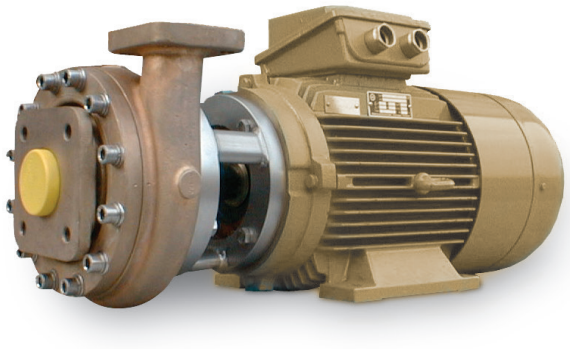
Liquids Pumped

- Nitrogen
- Oxygen
- Argon
- Methane
- Nitrous Oxide
- Carbon Dioxide

Typical Scope of Supply

- Pump and TEFC electrical motor shown
- Long life CFS mechanical seal
- Motor and seal purge ports

Model DCP – VFD
Trailer Pumps



120/160/180/220

Specifications

Pump Size	units	180 – 3
Flow Range	gpm	15 – 159
	lpm	60 – 600
NPSHR	feet	0.49 – 5.3
	meter	0.15 – 1.6
Differential Head	feet	118 – 1286
	meter	36 – 392
Pump Design Rating	hp	max. 49.6
	kw	max. 37
Speed Range	rpm	2950 – 8260
	hp	50 – 140

Consult Nikkiso ACD engineering to confirm available sizes and ratings.

Features & Benefits

- Multiple configurations and sizes accommodate lots of duties and applications
- Direct drive by variable speed electric motor
- Impeller wear ring reduces maintenance and improves efficiencies
- An inducer lowers the NPSH requirement
- Shaft seal design (mechanical, or gas riding) are state-of-the-art and prolong life without leakage
- Suits a large range of flow rates
- Intermittent and continuous duty

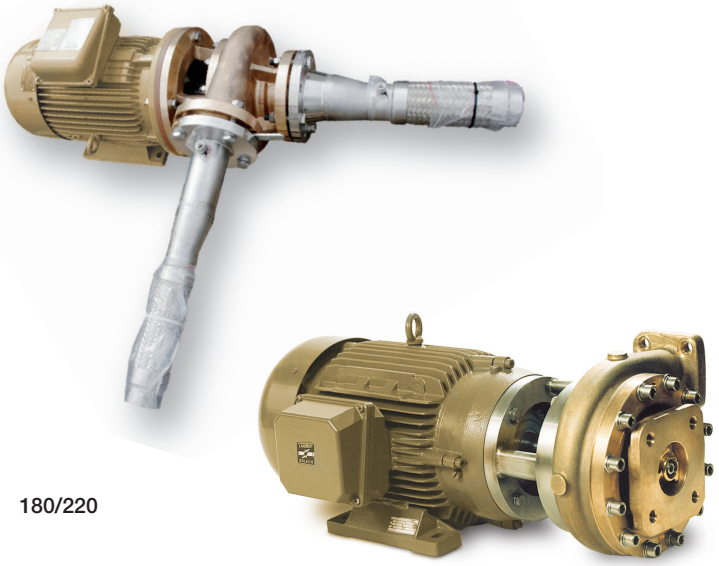
Applications

- Trailer and container loading and unloading
- Liquid storage transfer
- Process pumps

Liquids Pumped

- Nitrogen
- Oxygen
- Argon
- Methane

Model DCPS
Transfer Pumps



180/220

Specifications

Pump Size	units	180mm – 220mm
Flow Range	gpm	20 – 200
	lpm	75 – 750
NPSHR	feet	0.52 – 3.9
	meter	0.16 – 1.2
Differential Head	feet	180 – 328
	meter	36 – 100
Pump Design Rating	hp	7.3 – 34.8
	kw	5.5 – 18.5
Speed Range	rpm	2,950 – 4,000

Consult Nikkiso ACD engineering to confirm available sizes and ratings.

Features & Benefits

- Two pump sizes accommodate a wide range of flows
- Direct drive by fixed speed electric motor
- Specialty design for high suction pressures up to 22 bar
- An inducer lowers the NPSH requirement
- Special mechanical shaft seal for CO_2 & N_2O duty

Applications

- Trailer and container loading and unloading
- Liquid storage transfer

Liquids Pumped

- Carbon Dioxide
- Nitrous Oxide

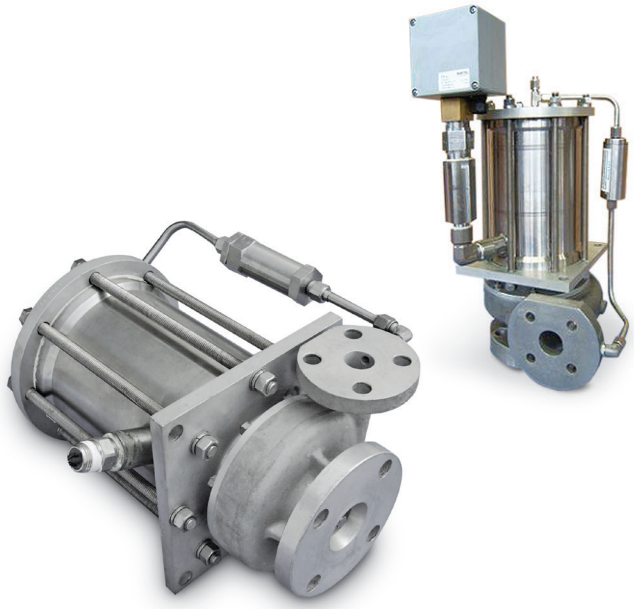
Typical Scope of Supply

- Single-stage pump equipped with low NPSHr inducer
- Direct driven with motor
- Variable frequency drive electric motor
- Mechanical seal with carbon seal ring, specially designed for high suction pressures and LCO_2

Optional Accessories

- Pump skid assembly
- Bearing purge kit
- Spare parts kit

Model AC-32
Vertical Sealless Pumps



Multiple sizes available
Not suitable for Oxygen service

Specifications

Pump Size	units	2 x 4 x 6
Flow Range	gpm	20 – 460
	lpm	75 – 1,514
NPSHR	feet	0.5 – 12
	meter	0.15 – 3.6
Differential Head	feet	21 – 500
	meter	6.40 – 150
Pump Design Rating	hp	3 – 40
	kw	2.24 – 30
Speed Range	rpm	1,500 – 7,200

Consult Nikkiso ACD engineering to confirm available sizes and ratings.

Features & Benefits

- Pump and motor are fully flooded with liquid, minimizing start-up and downtime and guaranteeing quick, responsive pumping
- Sealless design minimizes maintenance requirements – no mechanical seal
- No sump required – lowers cost
- Sealless zero leakage design is environmentally safe, releasing no volatile organic chemicals and contaminates (VOC's) into the atmosphere
- Multi-frequency motor provides an efficient and broad range of operation and power
- Electrical motor and bearing life is extended being cooled by the cryogen it is pumping, heat input is minimal and carried off by discharging liquid
- Low NPSH inducer coupled with a variable speed soft start motor eliminates cavitation at pump start-up
- Suitable for Class I, Div I (IEC Zone 0 and 1)
- Pass-thru connection

Applications

- LNG filling station pump
- Fuel loading pump
- LNG peaking plant

Liquids Pumped

- Nitrogen
- Argon
- Methane
- Ethylene

Model TC-34
Submerged Motor Pumps

1 x 2 x 6 - 2S/4S and 1.5 x 2.5 x 6 - 2S
Not suitable for Oxygen service

Specifications

Pump Size	units	1 x 2 x 6 - 2S
Flow Range	gpm	2 – 120
	lpm	8 – 450
NPSHR	feet	1.5 – 12
	meter	0.5 – 4
Differential Head	feet	50 – 1,200
	meter	15 – 365
Pump Design Rating	hp	10 up to 44
	kw	7.5 up to 33
Speed Range	rpm	1,500 – 7,200

Consult Nikkiso ACD engineering to confirm available sizes and ratings.

Features & Benefits

- Gastight design
- Pump and motor are fully submerged in liquid minimizing loss and guaranteeing quick response pumping
- Vacuum jacketed sump provides extremely low heat leak — ideal pumping conditions (optional)
- Sealless and submerged design minimizes maintenance requirements
- Vertical pump design provides greater stability and longer life
- Special design VFD motor provides broad range of operation

Applications

Use where product loss is not acceptable

- Liquid storage transfer
- Mobile delivery transfer – LAR, LN_2
- Vehicle fueling stations – LNG

Liquids Pumped

- Nitrogen
- Argon
- Ethylene
- Ethane
- Methane
- Propane
- Hydrogen

Optional Accessories

- Vacuum jacketed sump
- Variable frequency drive
- Differential pressure gauge
- Loss of prime detector (cavitation protection)
- Safety relief valve
- Dual conduit box per NFPA standards for LNG service

Model TC-34.2
State-of-the-Art Submerged Motor Pumps

Suction Pot Mounted Installation

In-tank and Removable Installations

Specifications

Flow Range	gpm	1 – 1,600
	lpm	4 – 6,056
	LH_2 kg/hr	15 – 25,000
NPSHR	feet	0.5 – 5
	meter	0.15 – 1.5
Differential Head	feet	50 – 4,000
	meter	15 – 1,220
Pump Design Rating	hp	3.35 – 335
	kw	2.5 – 250
Speed Range	rpm	2,000 – 10,000

Consult Nikkiso ACD engineering to confirm available sizes and ratings.

Multiple sizes available. Not suitable for Oxygen service.

Features & Benefits

- Active thrust balancing system for extended bearing life
- High efficiency hydraulics with extremely low NPSHR inducer
- Lightweight and compact
- Available in sump and in-tank designs
- Special design VFD drive provides operation point control over the entire pump operating range
- Features a quick electrical disconnect for ease of maintenance
- Permanent magnet motor
- All parts from wrought aluminum are precision machined
- Vacuum jacketed sump
- Heavy duty ceramic bearings

Applications

- Fuel supply systems for rail locomotives
- Low pressure marine fuel systems
- HP Booster pump
- Liquid storage transfer
- Bunkering operations
- Peak-shaving
- Trailer loading and off-loading
- High pressure pipeline injection
- Power generation

Complete Pumping System

- High-efficiency submerged pump
- Vacuum jacketed sump
- Custom made VFD drive – factory string tested
- Dual electrical feed thru hermetically sealed up to 500A

Liquids Pumped

- Nitrogen
- Argon
- Ethylene
- Ethane
- Methane
- Propane
- Hydrogen

Optional Accessories

- Differential pressure gauge
- Loss of prime detector (cavitation protection)
- Safety relief valve
- Dual conduit box per NFPA standards for LNG services
- Complete removal systems
- Long term storage container

Vertical Turbine Pumps
State-of-the-Art Submerged Motor Pumps

VTK-240
Multiple sizes available

Specifications

Flow Range	gpm	1,000 – 2,500
	lpm	3,785 – 9,462
NPSHR	feet	2 – 5 (162 – 2,800 gpm)
	meter	0.6 – 1.5 (613 – 10,598 lpm)
Differential Head	feet	46 – 1,937
	meter	14 – 590
Pump Design Rating	hp	167.5 – 335
	kw	125 – 250
Speed Range	rpm	2,000 – 4,200

Consult Nikkiso ACD engineering to confirm available sizes and ratings.

Features & Benefits

- Highly efficient, over 70% – lower operating costs and heat input into the fluid
- Modular design, 60 PSI/stage
- Active thrust balancing system for extended bearing life
- High efficiency hydraulics with extremely low NPSHR inducer
- Lightweight and compact
- Available in sump and in-tank designs
- Special design VFD drive provides operation point control over the entire pump operating range
- Features a quick electrical disconnect for ease of maintenance
- Permanent magnet motor
- All parts from wrought aluminum are precision machined
- Vacuum jacketed sump
- Heavy duty ceramic bearings

Applications

- Bunkering – barge-to-ship
- Low pressure marine fuel systems
- Send-out pump
- Liquid storage transfer
- Bunkering operations – ship-to-ship
- Pipeline feed
- FSRU loading/off-loading
- Railcar tender car loading and unloading

Liquids Pumped

- Nitrogen
- Argon
- Ethylene
- Ethane
- Methane
- Propane

Complete Pumping System

- High-efficiency submerged pump
- Removable in-tank with foot valve
- Custom made VFD drive – factory string tested
- Dual electrical feed thru hermetically sealed up to 500A

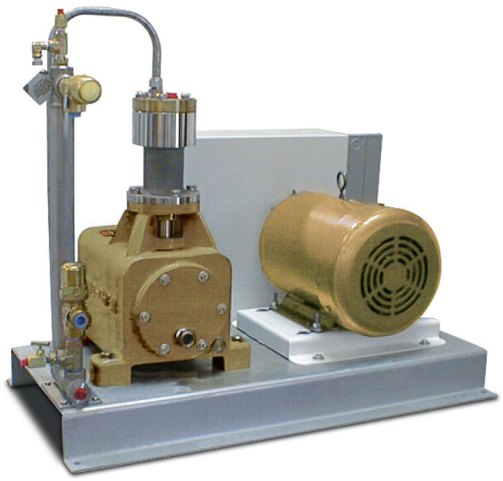
Optional Accessories

- Differential pressure gauge
- Loss of prime detector (cavitation protection)
- Safety relief valve
- Dual conduit box per NFPA standards for LNG services
- Complete removal systems
- Long term storage container

NIKKISO ACD

ACD Reciprocating Pumps

Model P1100
Cylinder Filling Pumps



Specifications

Bore x Stroke	in	1.75 x 1.50
	mm	44.5 x 38
Flow Rate	gpm	1.9 – 6.1
	lpm	7.2 – 23.1
Suction Pressure	psi	Min. 200
		Max. 450
	bar	Min. 13.7
		Max. 31
Pump Design Rating @1000 psi (69 bar)	hp	5 – 10
	kw	3.7 – 7.5
Maximum Working Pressure	psi	1,000
	bar	69
Speed Rating	rpm	140 - 450
Skid Settings	High pressure relief valve setting 1,200 psi (82.7 bar) High pressure bypass relief valve setting1,000 psi (69 bar) Burst disc pressure point 2000 psi (138 bar)	

Consult Nikkiso ACD engineering to confirm available sizes and ratings.

Features & Benefits

- Vertically positioned floating piston means longer life
- Simple cold end design assembly, easy maintenance
- Large piston diameter and longer pump stroke mean slower speeds and smooth operation
- Pump packing is easily adjusted through a large access port, which allows for extended packing life
- Splash oil lubricated drive provides extended pump life and minimizes maintenance requirements

Applications

- Carbon dioxide cylinder filling
- Nitrous oxide cylinder filling

Liquids Pumped

- Carbon Dioxide
- Nitrous Oxide

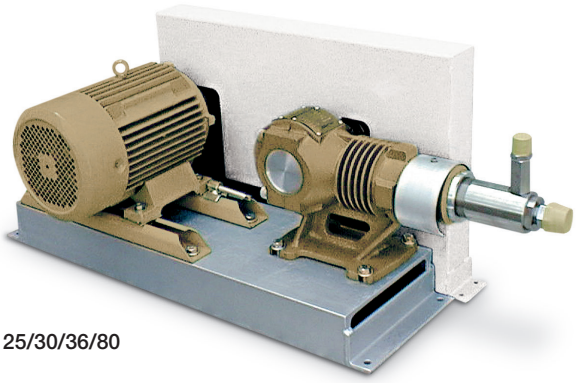
Typical Scope of Supply (SKID)

- Cold end and drive assembly, TEFC electric motor
- Galvanized steel base plate with drive and guard
- NEMA 1 pushbutton starter
- Surge chamber
- Relief valve and burst disc
- Pressure gauge and snubber
- Safety bypass relief valve arrangement automatically returns liquid to tank at 1000 psi (69 bar)
- Oil lubricated drive end (oil shipped loose)

FOR PUMPS INTENDED TO BE USED IN NITROUS OXIDE SERVICE:

Liquid Nitrous Oxide is a potentially dangerous fluid and must be handled with extreme care. See Compressed Gas Association standard CGA G-8.3-2016 for further information. Under certain combinations of temperature and pressure Nitrous Oxide can explosively decompose with serious consequences. Nitrous Oxide is an oxidizer that actively supports combustion. Nitrous Oxide handling equipment must be cleaned for Oxygen service. Design and construction of storage and piping systems for pumping liquid Nitrous Oxide must assure material compatibility and be such as to prevent loss of prime or “dry running” of pumps. Nitrous Oxide is an active solvent for many materials and material compatibility with Nitrous Oxide must be confirmed before their use. For additional historical information relating to hazards associated with Nitrous Oxide decomposition refer to Chemical Safety Board report number 2016-04-I-FL Dated February 2017.

Model RPSA
Cylinder Filling Pumps



25/30/36/80

Specifications: standard RPSA models

Bore x Stroke	in	1.57, 1.77 x .79	1.57, 1.77 x 1.26
	mm	40, 45 x 20	40, 45 x 32
Flow Rate	gpm	.66 – 3.2	1.0 – 5.1
	lpm	2.5 – 12.2	4.0 – 19.4
Pump Design Rating	hp	10	15
	kw	7.5	11
Maximum Discharge Pressure	psi	1,740	1,740
	bar	120	120
Maximum Suction Pressure	psi	435	435
	bar	30	30
Speed Range	rpm	117 - 450	117 - 450

Consult Nikkiso ACD engineering to confirm available sizes and ratings.

Features & Benefits

- Tungsten carbide coated piston helps increase the life of the seals
- Simple cold end design assembly for easy maintenance
- Heavy duty grease lubricated drive for longer life and less maintenance (regreasing not necessary)
- Pump packing is adjusted through a large access port for easy adjustments and extended packing life

Applications

- Carbon dioxide cylinder filling
- Nitrous oxide cylinder filling

Liquids Pumped

- Carbon Dioxide
- Nitrous Oxide

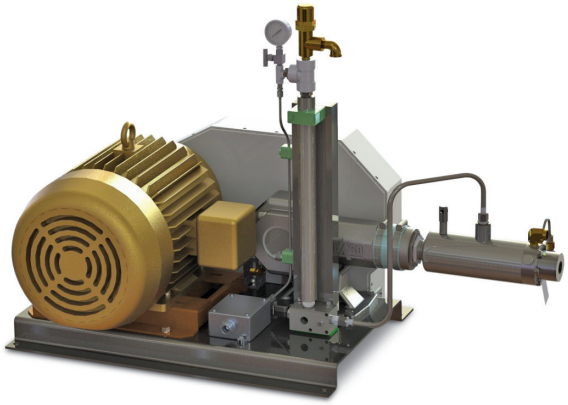
Typical Scope of Supply

- Cold end, grease lubricated drive assembly, and electric motor
- Galvanized steel base plate with belt guard
- Surge chamber and relief valve

FOR PUMPS INTENDED TO BE USED IN NITROUS OXIDE SERVICE:

Liquid Nitrous Oxide is a potentially dangerous fluid and must be handled with extreme care. See Compressed Gas Association standard CGA G-8.3-2016 for further information. Under certain combinations of temperature and pressure Nitrous Oxide can explosively decompose with serious consequences. Nitrous Oxide is an oxidizer that actively supports combustion. Nitrous Oxide handling equipment must be cleaned for Oxygen service. Design and construction of storage and piping systems for pumping liquid Nitrous Oxide must assure material compatibility and be such as to prevent loss of prime or “dry running” of pumps. Nitrous Oxide is an active solvent for many materials and material compatibility with Nitrous Oxide must be confirmed before their use. For additional historical information relating to hazards associated with Nitrous Oxide decomposition refer to Chemical Safety Board report number 2016-04-I-FL Dated February 2017.

Model ACPD
Cylinder Filling Pumps



Specifications: standard ACPD systems

Bore x Stroke	in	1.0 x 0.79	1.0 x 1.26	1.2 x 0.79	1.2 x 1.26
	mm	25 x 20	25 x 32	30 x 20	30 x 32
Flow Rate	gpm	0.23 – 1.20	0.37 – 1.92	0.34 – 1.73	0.54 – 2.76
	lpm	0.88 – 4.56	1.41 – 7.27	1.27 – 6.56	2.03 – 10.46
Maximum Pump Design Rating	hp	15	15	15	15
	kw	11	11	11	11
NPSPR	psi	2	2	2	2
	bar	0.1	0.1	0.1	0.1
Maximum Suction Pressure	psi	300	300	300	300
	bar	20.7	20.7	20.7	20.7
Maximum Working Pressure	psi	6000	6000	4000	4000
	bar	414	414	276	276
Speed Range	rpm	100 – 515	100 – 515	100 – 515	100 – 515

Consult Nikkiso ACD engineering to confirm available sizes and ratings.

Features & Benefits

- Vacuum jacketed cold end helps minimize heat leak leaks and reduce product loss
- Stainless steel drive housing for extended pump life
- Split drive end housing for easy maintenance access
- Monel suction strainer for oxygen compatibility
- Grease lubricated, sealed-for-life bearings for extended operation
- Extended stem vacuum port with positive seal for improved vacuum integrity
- Intermediate purge connection allows for extended packing life
- Positive locking drive coupling for improved safety operation

Applications

- Cylinder filling
- Test stand

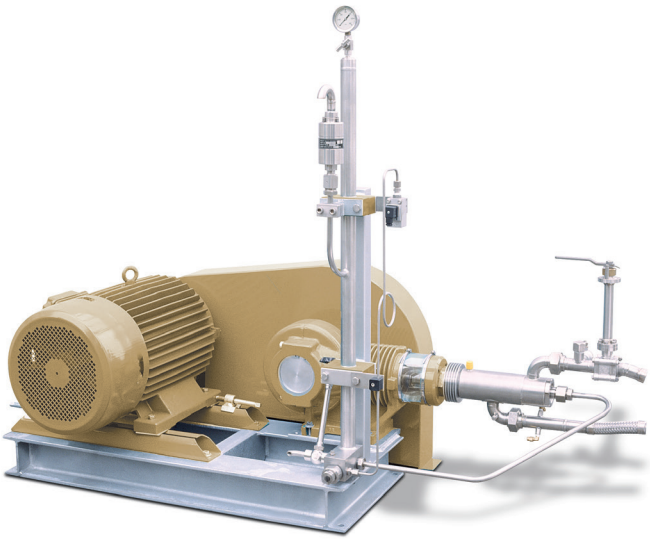
Liquids Pumped

- Nitrogen
- Oxygen
- Argon
- Hydrogen
- Methane

Typical Scope of Supply (SKID)

- Vacuum jacketed cold end with grease lubricated drive assembly
- Electric motor with belt drive and guard
- Stainless steel drive housing
- Hot dipped galvanized steel skid
- Over pressure switch and gauge
- PLC control panel (NEMA 4) with combination motor starter and running time meter (shipped loose)
- Discharge line with high pressure relief valve and surge chamber
- Low pressure vent valve
- Monel suction strainer

Model NOVA
Cylinder Filling Pumps



32/36/40

Specifications

Flow Range	gpm	0.79 – 4.5
	lpm	3 – 17
NPSP	bar	0.14
	PSI	2.0
Maximum Discharge Pressure	bar	400
	PSI	5801
Pump Design Rating	kw	11 – 30
	hp	15 – 40
NPSP	bar	0.14
Speed Range	rpm	100 – 450

Consult Nikkiso ACD engineering to confirm available sizes and ratings.

Features & Benefits

- Seal cartridge design allows for replacement in three minutes
- Low NPSPr due to unique suction valve position
- Cold end has only five components for quick and easy maintenance
- In-line pump assembly is perfect for operation with thermosyphon tanks
- Low pump mass for faster cool-down and lower gas losses
- Inlet design provides positive pump feed, which lowers NPSHR
- Reduced cold creep during idling due to special fin design, which reduces surface area
- Multiple configurations and sizes accommodate lots of duties and applications
- V-belt drive by fixed or variable speed electric motor
- Pump mounted on baseplate together with all required instrumentation
- CL-6 drive end with oil lubricated bearings for extended operation
- Lantern intermediate piece between cold end and drive
- Easy maintenance concept with exchangeable cold end
- Vacuum jacketed horizontal cold end reducing heat leakage

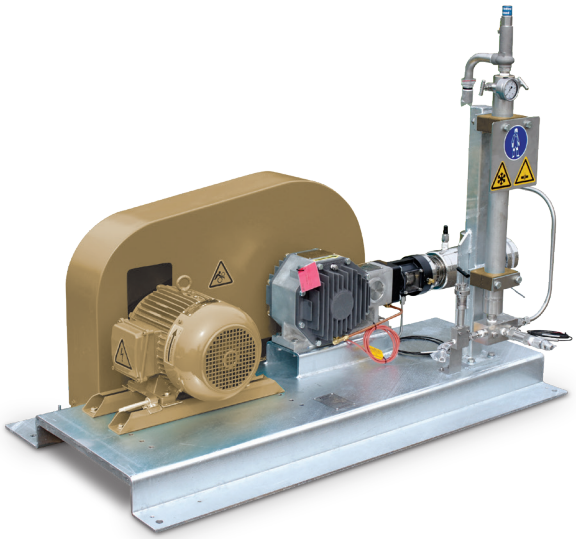
Applications

- Light to medium cylinder filling for flow rates up to 15.5 l/min and up to 420 bar discharge pressure

Liquids Pumped

- Nitrogen
- Oxygen
- Argon

Model SGCL 41.3
Cylinder Filling Pumps



Specifications

Flow Range	gpm	1.05 – 4.75
	lpm	4 – 18
NPSP	bar	0.1 – 0.68
	meter	0 – 10
Maximum Discharge Pressure	bar	420
	meter	6091
Pump Design Rating	hp	15 – 40
	kw	11 – 30
Speed Range	rpm	100 – 450

Consult Nikkiso ACD engineering to confirm available sizes and ratings.

Features & Benefits

- Single, double or triple cylinders modular design provides a wide range of flow rates
- Vacuum jacketed cold ends for minimal heat loss and lower NPSHr
- V-belt drive by fixed or variable speed electric motor
- Pump and motor mounted on baseplate together with all required instrumentation
- Splash oil lubricated drive allows higher bearing loads and increases the reliability
- Easy maintenance concept with exchangeable cold ends
- Multi-cylinder models are supplied with suction and return manifolds

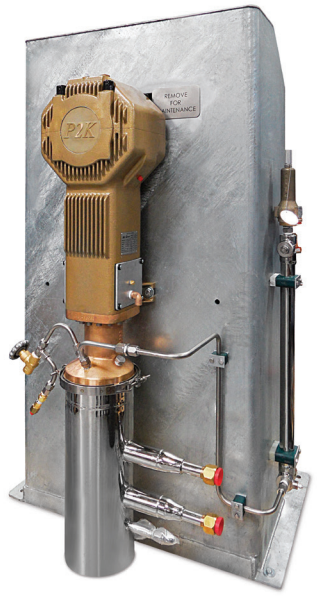
Applications

- Specially designed for heavy duty, high pressure cylinder and storage filling
- Light to medium cylinder filling for flow rates up to 5 – 30 l/min and up to 420 bar discharge pressure

Liquids Pumped

- Nitrogen
- Oxygen
- Argon
- Methane
- Hydrogen

Model P2K
The Safest Design in the Industry



Specifications

Bore x Stroke	in	1.25, 1.50 x 1.50	1.75 x 1.50	2.00 x 1.50
	mm	32, 38 x 38	44.5 x 38	50.8 x 38
Flow Rate	gpm	.31 – 3.6	.61 – 4.9	.80– 6.4
	lpm	1.2 – 13.6	2.3 – 18.5	3.0 – 24.2
Pump Design Rating	hp	7.5 – 20	10 – 20	15 – 20
	kw	5.6 – 15	7.5 – 15	11.2 – 15
Maximum Discharge Pressure	psi	6,000	4,500	3,500
	bar	414	310	241
NPSPR	psi	2	2	2
	bar	0.14	0.14	0.14
Maximum Suction Pressure	psi	300 (450#)	300 (450#)	300 (450#)
	bar	20.7 (31#)	20.7 (31#)	20.7 (31#)
Speed Range	rpm	50 - 415	40 - 415	50 - 415

Consult Nikkiso ACD engineering to confirm available sizes and ratings.
CO_2 Service

Features & Benefits

- Vertical pump design eliminates gravitational loading on the piston, extending sealing ring life and providing smoother suction valve operation
- Vertical installation offers less vibration, reduced noise, and a compact system footprint
- V-band clamp secures the sump to the intermediate, allowing quick and easy access to the cold end assembly
- External re-lubrication nipples for roller bearings and crosshead provide extended service life
- Replaceable crosshead wearband eliminates crosshead piston wear and reduces maintenance costs
- Packing rings at top of pushrod are retained in cartridges for easy replacement (no removal of sump and cold end required)
- Motor positioned on the backside of the pumping skid eliminates possible fire, explosion, or hazard in the event of a liquid oxygen leak
- Vertical cold end is submerged inside a vacuum-jacketed liquid sump, minimizing heat leak and increasing system efficiency (particularly in poor suction conditions)
- Pump assembly and spare parts are interchangeable with the PD3000 pump
- Easy cold end maintenance by swiveling the pump and drive end 45°

Typical Scope of Supply

- Grease-lubricated drive assembly and vacuum-jacketed cold end
- Electric motor with belt drive and guard
- Hot-dipped galvanized steel skid frame
- Over pressure switch gauge (shipped loose)
- Control panel with combination motor starter and running time meter (shipped loose), relay logic
- Vent line with manual valve and low pressure relief valve
- Monel suction strainer
- High pressure relief valve with discharge line and surge chamber

Applications

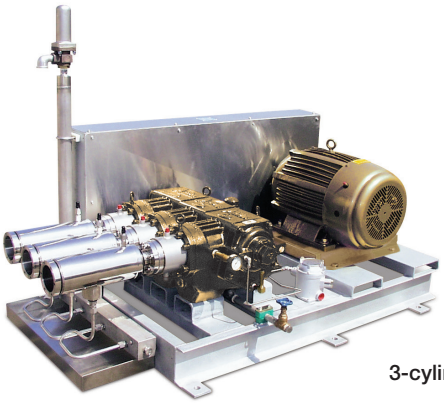
- Heavy duty cylinder filling
- Medium duty storage filling
- Unattended, automatic storage filling

Liquids Pumped

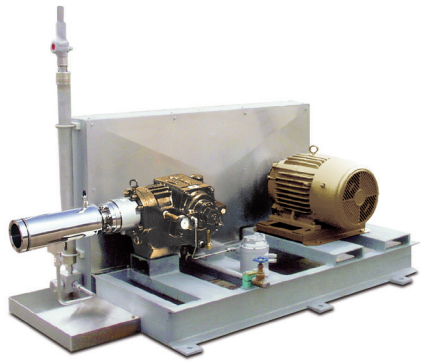
- N_2, O_2, Ar, CO_2, N_2O
- Methane
- Ethylene

FOR PUMPS INTENDED TO BE USED IN NITROUS OXIDE SERVICE: Liquid Nitrous Oxide is a potentially dangerous fluid and must be handled with extreme care. See Compressed Gas Association standard CGA G-8.3-2016 for further information. Under certain combinations of temperature and pressure Nitrous Oxide can explosively decompose with serious consequences. Nitrous Oxide is an oxidizer that actively supports combustion. Nitrous Oxide handling equipment must be cleaned for Oxygen service. Design and construction of storage and piping systems for pumping liquid Nitrous Oxide must assure material compatibility and be such as to prevent loss of prime or "dry running" of pumps. Nitrous Oxide is an active solvent for many materials and material compatibility with Nitrous Oxide must be confirmed before their use. For additional historical information relating to hazards associated with Nitrous Oxide decomposition refer to Chemical Safety Board report number 2016-04-I-FL Dated February 2017.

Model SGV
Storage Filling Pumps



3-cylinder SGV



1-cylinder SGV

Specifications

Bore x Stroke	in	1.25 x 1.38	1.625 x 1.38	1.97 x 1.38
	mm	32 x 35	41 x 35	50 x 35
Flow Rate	gpm	0.94 – 15.3	1.6 – 25.9	2.35 – 38.1
	lpm	3.56 – 57.9	6.1 – 98.0	8.9 – 144.2
	LH_2 gpm	0.90 – 10.8	1.52 – 18.3	2.25 – 26.9
Pump Design Rating	hp	15 – 200	15 – 200	15 – 200
	kw	11 – 150	11 – 150	11 – 150
Maximum Discharge Pressure	psi	10,000	6,000	6,000
	bar	690	420	420
NPSPR	psi	10	5	5
	bar	0.70	0.35	0.35
Speed Range	rpm	150 - 800	150 - 800	150 - 800

Consult Nikkiso ACD engineering to confirm available sizes and ratings.

Features & Benefits

- Modular, compact displacement pumps available in 1, 2, or 3 cylinder configurations provide a wide range of flows
- Vacuum jacketed cold end for minimal cool-down losses and economical operation, ideal for liquid hydrogen
- Pressurized oil lubricated drive with integral oil pump and reservoir, allows higher bearing loads/prevent oil leakage
- Belt driven by electric drive motors allows for extended pump duty
- Improved cold end assembly design extends seal life

Applications

- Specially designed for storage filling
- Special medium to heavy duty applications
- LNG, LN_2, LH_2 process

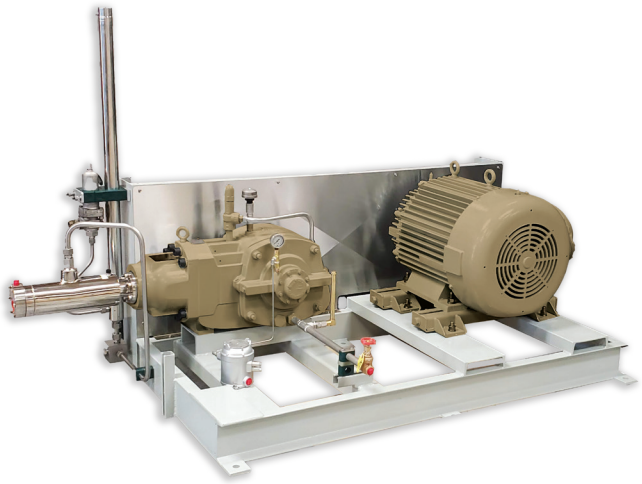
Liquids Pumped

- Nitrogen
- Oxygen
- Argon
- Methane
- Hydrogen

Typical Scope of Supply

- Vacuum jacketed cold end with pressure oil lubricated drive end
- Positive locking coupling
- Standard suction adapter with Monel strainer
- Distance piece with purge ports
- Hot dipped galvanized steel skid
- TEFC motor
- High pressure relief valve with discharge line and surge chamber
- Drip pan kit for LH_2 only
- Suction/vapor return manifold for multiple cylinders

Model MP-100
Fuel Station/Storage Filling/Special Application Pump



Specifications

Bore x Stroke (single cylinder)	in	1.625 x 2.25	1.97 x 2.25
	mm	41 x 57	50 x 57
Flow Rate	gpm	2.6 – 51.5	3.8 – 75.7
	lpm	9.7 – 195.2	14.3 – 286.9
	LH_2 kg/hr	30 – 600	40 – 850
Pump Design Rating	hp	15 – 500	15 – 450
	kw	11 – 373	11 – 336
Maximum Discharge Pressure	psi	13,000	8,000
	bar	900	550
NPSPR	psi	5 – 15	5 – 10
	bar	0.35 – 1.0	0.35 – 0.70
Speed Range	rpm	150 – 600	150 – 600

Consult Nikkiso ACD engineering to confirm available sizes and ratings.

Features & Benefits

- Modular, compact displacement pumps available in 1, 2, 3 or 5 cylinder configurations provide a wide range of flows
- Vacuum jacketed cold end for minimal cool-down losses and economical operation, ideal for liquid hydrogen
- Pressurized oil lubricated drive with integral oil pump and reservoir, allows higher bearing loads/prevent oil leakage
- Compatible with external oil cooler or lube system for continuous duty applications
- State-of-the-art internal sealing design for high efficiency and minimized losses

Applications

- Storage filling
- Special medium to heavy duty applications
- Continuous duty applications
- LH_2 fueling station applications
- Marine fuel gas systems

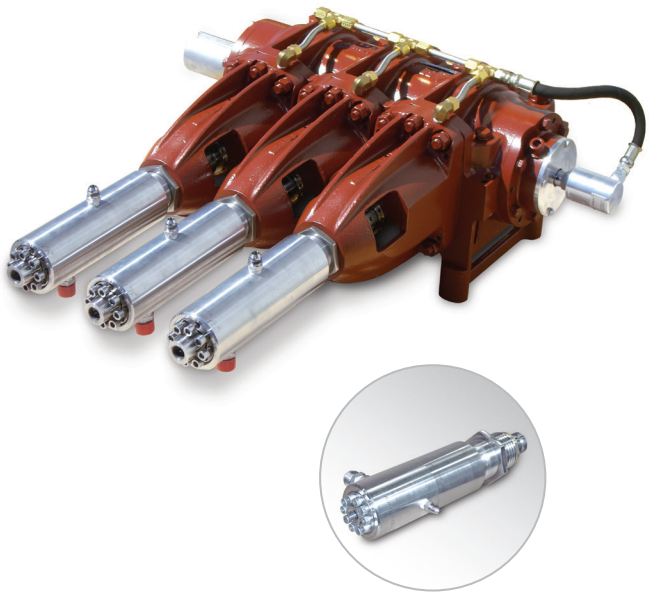
Liquids Pumped

- Nitrogen
- Oxygen
- Argon
- Methane
- Hydrogen

Typical Scope of Supply

- Vacuum jacketed cold end with pressure oil lubricated drive end
- Standard suction adapter with Monel strainer
- Distance piece with purge ports
- Hot dipped galvanized steel skid
- TEFC motor
- High pressure relief valve with discharge line and surge chamber
- Drip pan kit for LH_2 applications
- Suction/vapor return manifold for multiple cylinder configurations

Model 3-GUPD
High Flow/High Pressure Pumps



Available with SG cold end, 1.625” bore

Specifications

Bore x Stroke	in	1.25 x 1.125	1.625 x 1.125	2.00 x 1.125
		1.25 x 1.3	1.625 x 1.3	2.00 x 1.3
		1.25 x 1.5	1.625 x 1.5	2.00 x 1.5
Flow Rate	gpm	1.5 – 18.3	2.6 – 32.0	3.9 – 48.8
	lpm	5.7 – 69.5	9.8 – 121.0	14.7 – 185.0
Pump Design Rating	hp	205	205	205
	kw	153	153	153
Maximum Discharge Pressure	psi	17,000	10,000	6,600
	bar	1,172	690	455
NPSPR	psi	60	60	60
	bar	4.1	4.1	4.1
Speed Range	rpm	100 – 940	100 – 940	100 – 940

Consult Nikkiso ACD engineering to confirm available sizes and ratings.

Features & Benefits

- Rugged, heavy duty construction allows for high reliability in oil well service operations
- Main shaft is pressure lubricated minimizing wear and tear on bearings/ crosshead piston while keeping all components cool
- Interchangeable with SG cold ends expanding capabilities and all cold ends have minimal material for quick cool-down and minimal wear and tear at start-up
- Multiple cold end sizes and drive end strokes allow for wide range of flows and pressures providing flexibility to end users and applications

Applications

- Oil well service
- High pressure pumping systems
- Mobile pumping applications
- N_2 purging

Liquids Pumped

- Nitrogen
- Methane
- Ethylene

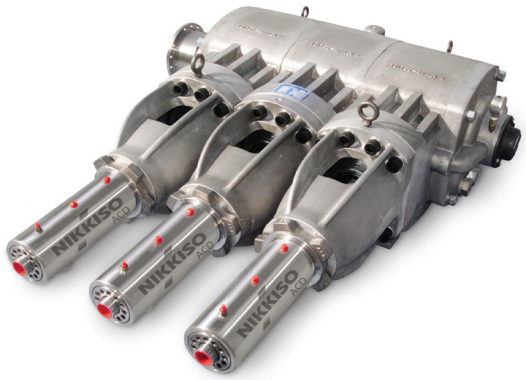
Typical Scope of Supply

- Foot-mount pump shown (cold ends & drive end)
- Digital tach adapter
- LN_2 tested

Optional Accessories

- SG, non-vacuum jacketed cold ends, p/n 60740-1
- Mechanical tach adapter
- Boost pump

Model SLS
High Flow/Pressure Pumps



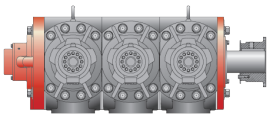
3-SLS

5-SLS

SLS Warm Ends

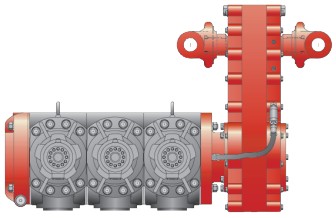
3-SLS

- Counter balance optional
- Left or right hand
- Diverted cooling
- Internal or External Oil Pump



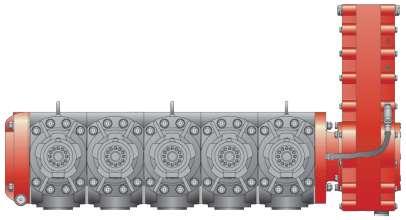
3-SLSGRO

- Counter balance optional
- Gear reduction
- External oil pump
- Diverted cooling



5-SLSGRO

- Counter balance optional
- Gear reduction
- External oil pump
- Digital tachometer



Consult Nikkiso ACD engineering to confirm available sizes and ratings.

Features & Benefits

- Improved drive end design allows for longer life and cooler temperatures during operation
- Multiple configurations enable adaptability and conformity to mobile and/or stationary applications using a standard base model
- Better than 30-to-one turndown ratios allows for a wide range of operating parameters, including low enough flows to meet coil-tubing applications
- Non-Key Polygon Design reduces drive end failure risk due to shaft key

Nitrogen Purging

Nitrogen purging using ACD pumps is a technique used to replace hydrocarbon vapors, flammable and toxic gases or air with an environmentally safe and inert dry atmosphere. The two most common methods of purging are displacement and dilution. The geometry of the process system determines which method is used. For simple systems, displacement purging is usually more effective in terms.

High Temperature Nitrogen

Delicate operations such as furnace bake-outs, catalyst regeneration and hydrocarbon and solvent stripping have been safely performed using high temperature inert.

Liquids Pumped

- Nitrogen
- Methane

Model MSP-GU
Medium Flow/High Pressure Pumps for Marine Applications

Specifications

Flow Rate	1 – 10 m^3/h
Pressure	200 – 414 bar
Suction Pressure Req'd	4 bar (above saturation pressure)
Power Required	50 – 150 t

Model	Dimensions (LxWxH)	Weight
DNS-100	4700mm x 2300mm x 2000mm	9000 kg
DNS-150	4700mm x 2300mm x 2000mm	9000 kg
DNX-100	4700mm x 2300mm x 2000mm	11000 kg
DNX-150	4700mm x 2300mm x 2000mm	11000 kg
DVX-100	4700mm x 2300mm x 2200mm	13000 kg
DVX-150	4700mm x 2300mm x 2200mm	13000 kg
SNS-100	3300mm x 2300mm x 2000mm	7000 kg
SNS-150	3300mm x 2300mm x 2000mm	7000 kg
SNX-100	3300mm x 2300mm x 2000mm	9000 kg
SNX-150	3300mm x 2300mm x 2000mm	9000 kg
SVX-100	3300mm x 2300mm x 2200mm	11000 kg
SVX-150	3300mm x 2300mm x 2200mm	11000 kg

Consult Nikkiso ACD engineering to confirm available sizes and ratings.

Features & Benefits

- Electric drive system for simple and reliable flow control (no HPU required)
- Total system redundancy
  - 100% pump redundancy
  - 100% valve and instrumentation redundancy
  - 100% drive system redundancy (motors and VFDs)
- Up to 10-to-one turndown ratio
- Compact foot print for ease of installation and reduced space claims

High Pressure Fuel Pump System

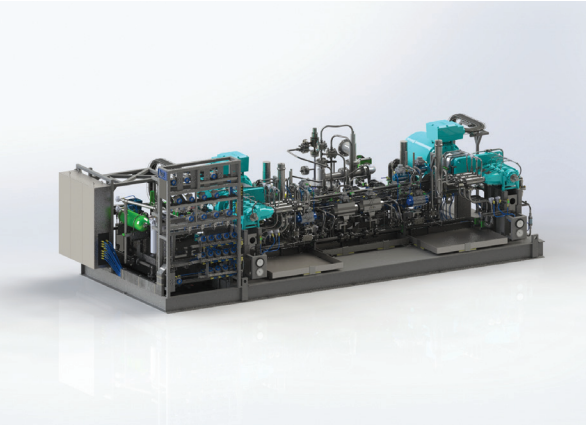
Over 50 LNG fueled ships operate with ACD pumps, more than any other brand

- Class approvals ABS, BV, DNV, LR
- Designed for all shipboards applications
- Meets all ME-GI requirements
- MSP-GU and MSP-SL marine pumps are derived from over 40 years in Enhanced Oil Recovery applications, the most strenuous and demanding of any HP pump application.
- MSP-GU and MSP-SL pumps are built in the USA and the systems are assembled in either Korea or China, depending on the customer's location and needs

Typical Scope of Supply

- High pressure pumps, gearbox or beltbox, and electric motors on a common steel skid.
- Forced lubrication system for longer lifetime for pump drive operation
- All necessary valves and instrumentation for proper functionality and classification society compliance.
- Variable Frequency Drives for high pressure pump motors
- Several standard options are available upon request including Control Panels, High Pressure Control Valves, and spare components.

Model MSP-SL
High Flow/High Pressure Pumps For Marine Applications



Specifications

Flow Rate	1 – 31 m^3/h
Pressure	200 – 414 bar
Suction Pressure Req'd	4 bar (above saturation pressure)
Power Required	50 – 300 kW

Model	Dimensions (LxWxH)	Weight
DNS-100	5500mm x 2700mm x 2000mm	10000 kg
DNS-150	5500mm x 2700mm x 1900mm	10000 kg
DNS-200	5500mm x 2700mm x 1900mm	11000 kg
DNX-100	6700mm x 2700mm x 1900mm	14000 kg
DNX-150	6700mm x 2700mm x 1900mm	14000 kg
DNX-200	5500mm x 2700mm x 2300mm	13000 kg
DVX-100	6700mm x 2700mm x 2300mm	15000 kg
DVX-150	6700mm x 2700mm x 2300mm	15000 kg
SNS-100	3400mm x 2700mm x 1900mm	7500 kg
SNS-150	3400mm x 2700mm x 1900mm	7500 kg
SNX-100	4800mm x 2700mm x 1900mm	9500 kg
SNX-150	4800mm x 2700mm x 1900mm	9500 kg
SVX-100	4800mm x 2700mm x 2300mm	10000 kg
SVX-150	4800mm x 2700mm x 2300mm	10000 kg

Consult Nikkiso ACD engineering to confirm available sizes and ratings.

Features & Benefits

- Electric drive system for simple and reliable flow control (no HPU required)
- Total system redundancy
  - 100% pump redundancy
  - 100% valve and instrumentation redundancy
  - 100% drive system redundancy (motors and VFDs)
- Up to 10-to-one turndown ratio
- Compact foot print for ease of installation and reduced space claims

High Pressure Fuel Pump System

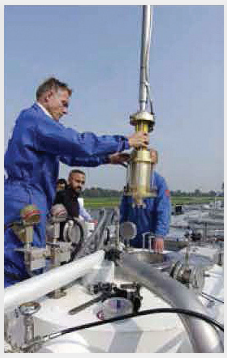
Over 50 LNG fueled ships operate with ACD pumps, more than any other brand

- Class approvals ABS, BV, DNV, LR
- Designed for all shipboards applications
- Meets all ME-GI requirements
- MSP-GU and MSP-SL marine pumps are derived from over 40 years in Enhanced Oil Recovery applications, the most strenuous and demanding of any HP pump application.
- MSP-GU and MSP-SL pumps are built in the USA and the systems are assembled in either Korea or China, depending on the customer's location and needs

Typical Scope of Supply

- High pressure pumps, gearbox or beltbox, and electric motors on a common steel skid.
- Forced lubrication system for longer lifetime for pump drive operation
- All necessary valves and instrumentation for proper functionality and classification society compliance.
- Variable Frequency Drives for high pressure pump motors
- Several standard options are available upon request including Control Panels, High Pressure Control Valves, and spare components.

Service and Support



Installation, Commissioning and Service Support

- Class approvals ABS, DNV, LR
- Designed for cargo & container ships
- Meets all ME-GI requirements
- Actual operating experience

Annual Service Package – Basic

- 24/7 technical support via phone and/or email with dedicated contact information
- Standard exchange items:

Item/Assembly	Exchange Interval	Standard Cost (USD)	Additional Billing Apply**
MSP-SL Cold ends	3,000 – 5,000 hrs	Contact ACD*	Yes
Lube Oil Filters	Annual	Contact ACD*	No
MSP-34.2 Assembly	20,000 hours	Contact ACD*	No

* Wear parts and labor included
** May apply based on wear of non-standard exchange parts

- Training will be provided to ship technicians once per year for:
  - 3 training days
  - Installation and removal of cold ends, filters and submerged pumps
  - Normal operation of pump systems and trouble shooting techniques
- 48 hour shipping of parts/cold ends from one of ACD's global service locations
- Non-Emergency Call outs

Global Network

ACD
ACD – Atlanta
ACD – California
ACD – Dubai
ACD – Houston
ACD – India
ACD – Pittsburgh
NCEIG GmbH (ACD Cryo)
Cosmodyne
Cosmodyne - India
CryoCanada – Red Deer
CryoCanada – Toronto
Cryogenic Industries – China
Cryogenic Industries – Korea
Cryogenic Industries – Malaysia
Cryoquip
Cryoquip – Australia
Cryoquip – China
Cryoquip – India
Cryoquip – Malaysia
Cryoquip – UK

NIKKISO CRYO

Nikkiso Cryo
Centrifugal Pumps & Turbines

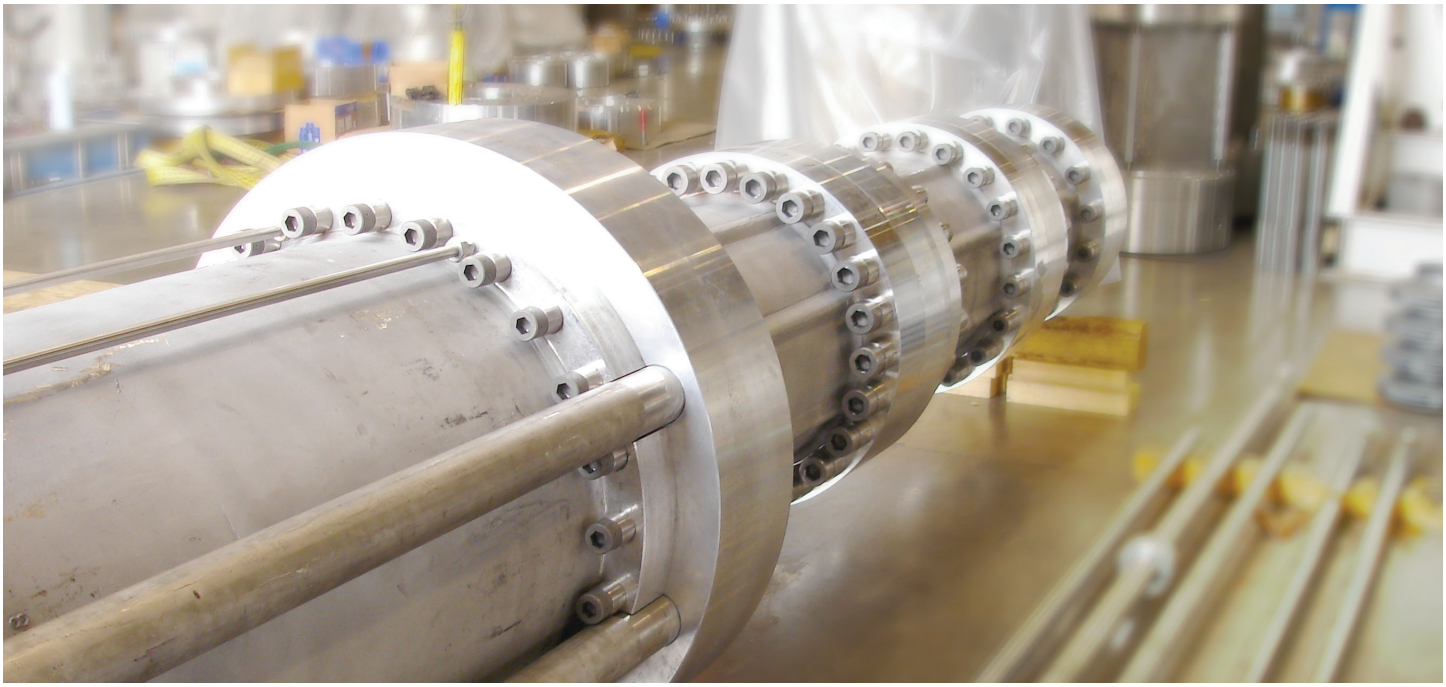
Submerged Motor Cryogenic Pumps

Unmatched Reliability, Quality and Safety

As part of the Nikkiso Company global organization, our “original technologies” provide our customers with the confidence in knowing they are receiving the latest technology and the highest standards of engineering available.

Located in North Las Vegas, Nevada, in the USA, Nikkiso Cryo offers a full range of submerged pumps for LNG, LPG, LEG, LN_2, liquid propylene, Ammonia, LH2 and many other liquefied gases.

With design, production and test facilities in both the USA and Japan, sales offices in Las Vegas, Houston, London, Tokyo, Germany, Italy, Finland, Turkey, Qatar, U.A.E., S. Korea, China, Taiwan, Malaysia, India and Australia, Nikkiso Cryo offers prompt and full support for all of our customers worldwide.

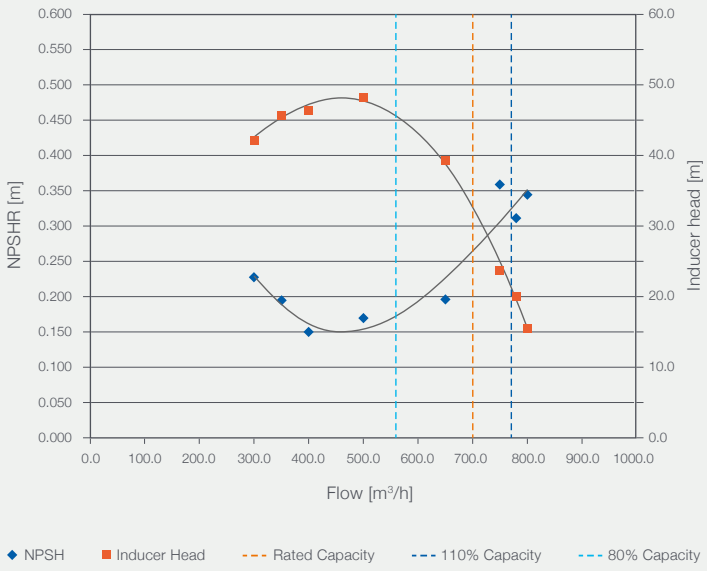


State-of-the-Art Inducers

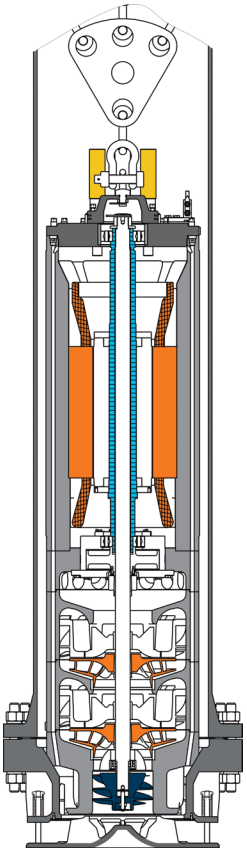
Specially developed with high speed inducer technology from the aerospace industry, the inducers allow the pumps to reduce liquid levels to extremely low levels.

For pumps operating in liquefied gases, where pressures and temperatures of the pumped fluid are sometimes near their boiling point, the use of inducers in the pump inlet is necessary to ensure adequate NPSHR or Net Positive Suction Head Required, is supplied to the main centrifugal impellers. Nikkiso Cryo uses low solidity fan-type inducers as well as high solidity spiral-type inducers depending on the application. These inducers with high suction specific speeds, provide excellent low suction pressure performance over a wide flow range.

For applications which require tank levels to be minimized as much as possible, Nikkiso Cryo has developed a spiral inducer with very high suction specific speeds. Our ZEN—Zero Enabled NPSH—Inducer was specially developed based on high speed inducer technology from the aerospace industry to allow the pumps to reduce liquid levels to extremely low levels, which maximizes usable tank volume.



Removable In-Tank Pumps



Features & Benefits

Removable, or in-tank pumps offer the advantage of overhead removal and installation without taking the tank out of service. The pump operates at the bottom of a purpose-built pump column through which it is installed and removed. The column provides the fluid discharge from the pump to the top of the tank and contains the lifting cables as well as the power cables. Our ZEN (Zero Enabled NPSH) inducer was specially developed to allow the pumps to reduce liquid levels to extremely low levels.

Note: Our pumps compact size makes them able to handle column sizes typically 2 sizes smaller than standard industry size, or to manage up to 30% higher flow in the same column size.their unmatched reliability raises their average maintenance intervals to 30% of competition's.

Applications

Liquefaction & FPSO

- Loading Pump
- Recirculating Pump
- Reflux Pump

Regasification, FSRU & Peakshavers

- Primary Pump
- Emergency Pump (FSRU)

Carriers

- Emergency Pumps

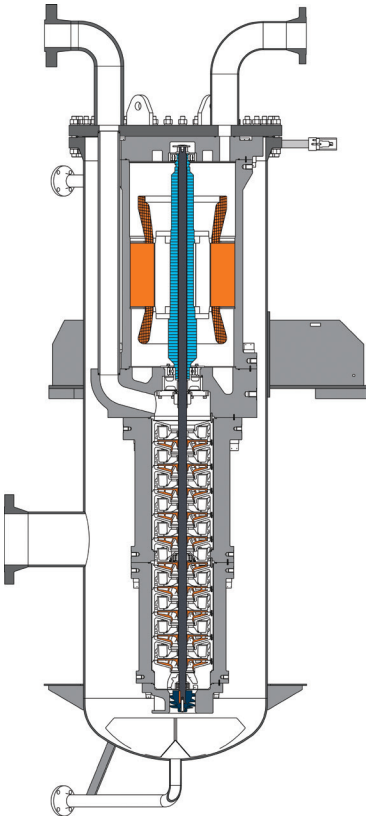
Liquids Pumped

- Nitrogen
- Propane
- Butane
- Ethylene
- Ethane
- Methane
- Propylene
- LNH3
- LH2
- And more

Scope of Supply

- Pump
- Foot Valve
- Lifting & Electrical Cables
- Head Plate
- Feed Through, Junction Box
- Vibration Monitoring System

Suction Vessel Mounted Pumps



Features & Benefits

This design is provided with the pump and suction vessel which become an integral part of the piping system with external suction and discharge connections. The pump is mounted to the top or headplate of the vessel such that the pump, motor and fluid product are totally contained within the pressure vessel. Shaft seals are eliminated. The pump inlet is below the suction vessel inlet which allows the source tank liquid levels to be lowered to a minimum.

Our superior efficiency reduces energy consumption by 10 to 15 points which translates into millions in savings over the lifetime of the terminal for the Operator.

Applications

Liquefaction & FPSO

- Transfer Pump
- Booster Pump

Regasification, FSRU & Peakshavers

- Send Out Pump
- Line Packing Pump

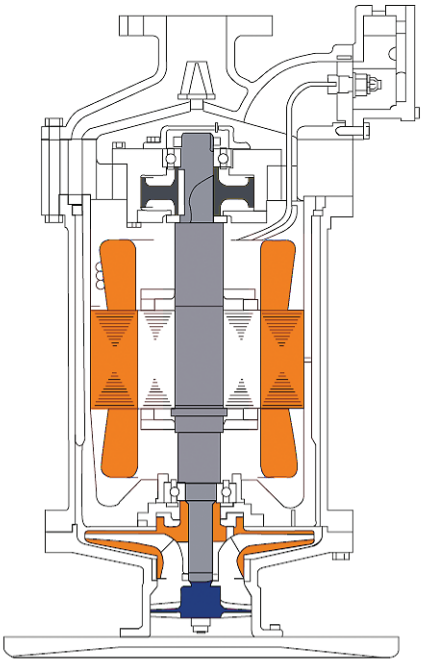
Liquids Pumped

- Nitrogen
- Propane
- Butane
- Ethylene
- Ethane
- Methane
- Propylene
- LNH3
- LH2
- And more

Scope of Supply

- Pump
- Vessel & Head Plate
- Feed Through, Junction Box
- Vibration Monitoring System
- Vessel Cooling System

Fixed In-Tank Pumps



Features & Benefits

This pump type is mounted directly to supports in the bottom of a storage tank and connected to a discharge pipe which extends to the top of the tank and out to the discharge piping. This simple and low-cost design is used in liquefied gas carriers and in any other application where removing the liquid from the tank for maintenance is a normal or required process and can be accomplished without excessive costs to the tank or system.

Through our newly composed JC Carter branch, we are offering high performance pumps with capacity that allows to save up to 3 hours in offloading each ship and NPSH that allows to reduce deadstock to a minimum. Our superior reliability allows maintenance every 8 to 10 years.

Applications

Liquefaction & FPSO

- Spray Unloading Pump (FPSO)

Regasification, FSRU & Peakshavers

- Unloading pump (FSRU)
- Primary Pump (FSRU)

Carriers

- Ship Offloading Pumps
- Spray/Stripping Pumps
- Fuel Gas Pumps

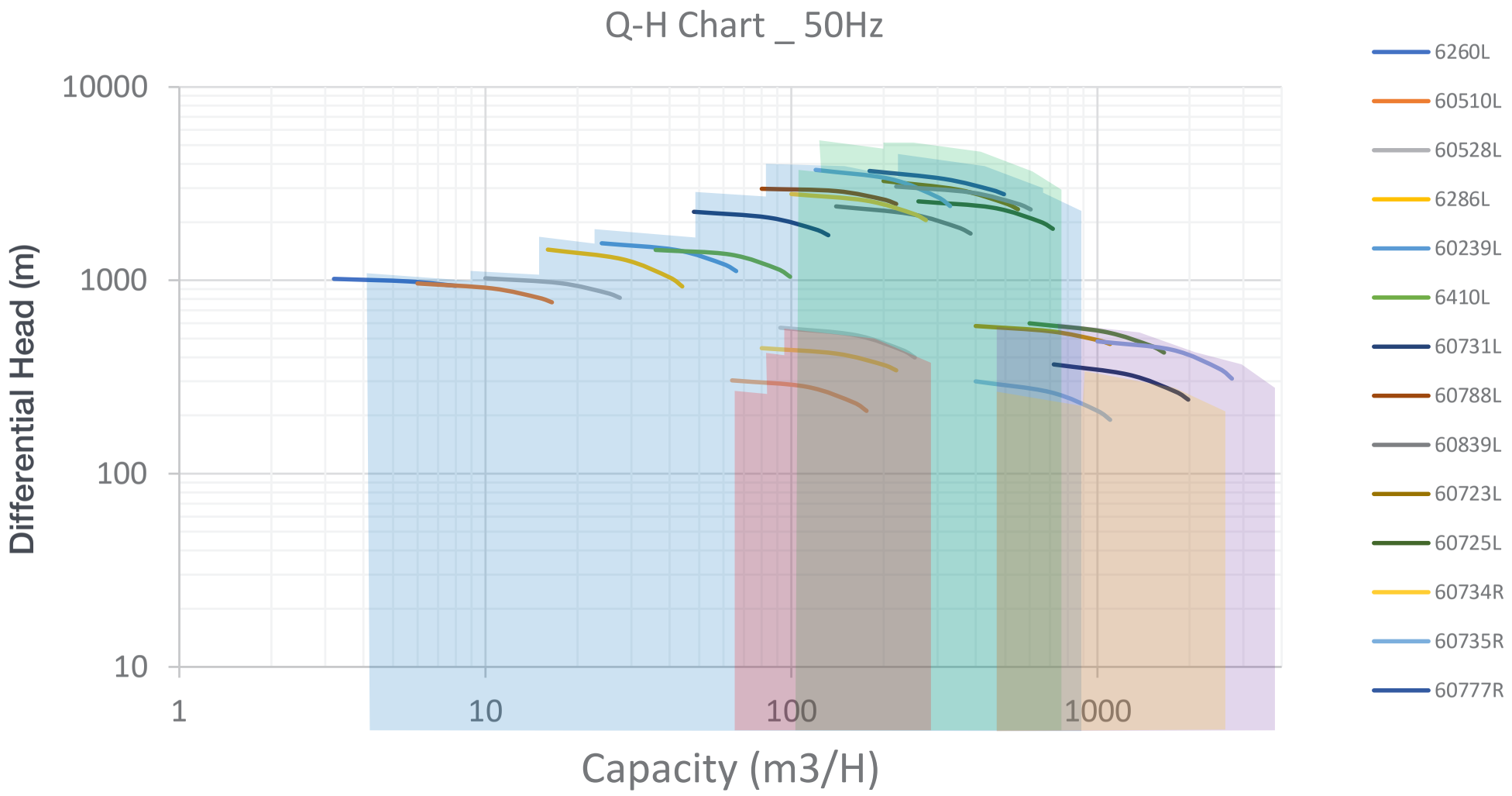
Liquids Pumped

- Nitrogen
- Propane
- Butane
- Ethylene
- Ethane
- Methane
- Propylene
- And more
- LNH3
- LH2
- And more

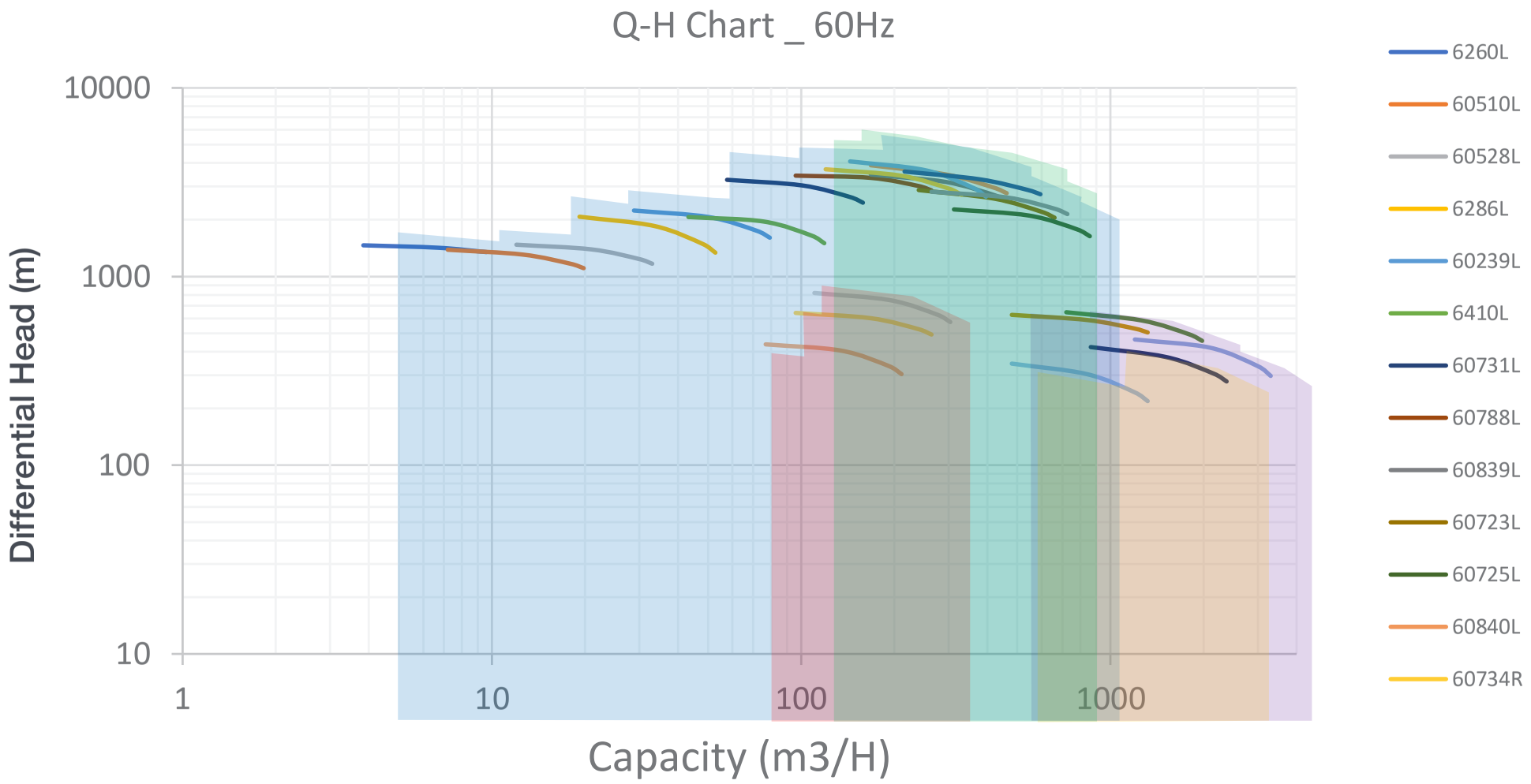
Scope of Supply

- Pump
- Feed Through, Junction Box
- Vibration Monitoring System

NCI Pumps Performance Curves Envelope at 50 Hz



NCI Pumps Performance Curves Envelope at 50 Hz



Variable Phase Turbine & Liquid Expander Turbine

Variable Phase Turbine (VPT)

Our latest Variable Phase Turbine (VPT) features a patented design that efficiently handles liquid, vapor or any combination during operation. No other product currently available on the market is capable of withstanding two phase fluids by design.

The VPT's flashing liquid expander technology offers significant efficiency improvements in liquid production while reducing the impact of vapor in the system. This technology can be applied to any LNG liquefaction process including the most common liquefaction processes—APCI and ConocoPhillips Cascade. It can be applied on either the LNG mainstream or the MR refrigeration stream. In addition, it can replace the JT valve in any application.

This product enhances targeted reduction in carbon emissions, an increase in liquid production, overall process efficiency and a reduction in vapor generation. It also provides further reduction in the downstream pressure down tank pressure in APCI process.

This turbine represents a significant step toward the reduction of emissions while at the same time offering cost savings to our customers. Proven tests have shown that return on customer's investment can be achieved within 6-12 months, a significant value long term for customers.

Benefits of the Nikkiso Pump Group VPT Product Line:

- Patented design which efficiently handles any combination liquid-vapor mixtures. Current available products are not able to withstand two phase fluids without breaking or damage
- Parallel installation to Joule-Thompson valves to extract heat from the fluid and produce power
- Enhances targeted reduction in carbon emissions
- Isentropic (ideal) expansion, up to 85% efficiency
- Increase in liquid production, and reduction in vapor generation
- VPT accepts liquid and 2-phase fluid at inlet
- VPT delivers liquid and 2-phase fluid at outlet
  - Provides further reduction in the downstream pressure down tank pressure in APCI process
- Proven tests have shown that return on customers investment can be achieved within 6-12 months

Nikkiso is committed to the continuous improvement of our products and services to meet or exceed the requirements of our customers. It is through this commitment that Nikkiso ACD and Nikkiso Cryo has developed a reputation as a loyal and trustworthy supplier producing quality products known for their high reliability.

Quality and Safety

Strive to Achieve the Highest Level of Quality Possible

Nikkiso Cryo is committed to continuous improvement of our products and services and to meet or exceed the requirements of our customers. It is through this commitment that Nikkiso Cryo has developed a reputation as a loyal and trustworthy supplier producing a quality product known for its high reliability.

Certified to ISO 9001

Our internal corrective action system helps assure that any lessons learned are immediately corrected not only for the current project, but in all of our internal systems to ensure all future processes and designs are as trouble-free as possible. We believe that quality is a continuous process that requires us to never stop trying to improve.


NSAI

Certificate of Registration of Occupational Health and Safety Management System to ISO 45001:2018

The National Standards Authority of Ireland Inc. certifies that:

Nikkiso Cryo Incorporated
4661 Eaker Street
North Las Vegas, NV 89081
USA

Central Function, Design, Testing, Assembly, Shipping and Service

Nikkiso Cryo Incorporated
4545 Lamb Blvd.
Las Vegas, NV 89115
USA

Administration and Sales

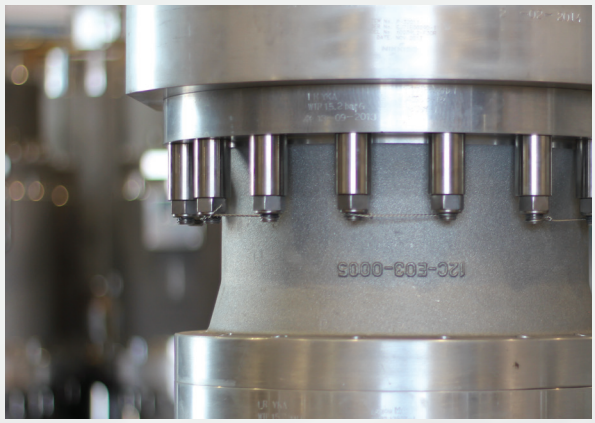
has been assessed and deemed to comply with the requirements of the above standard in respect of the scope of operations given below:

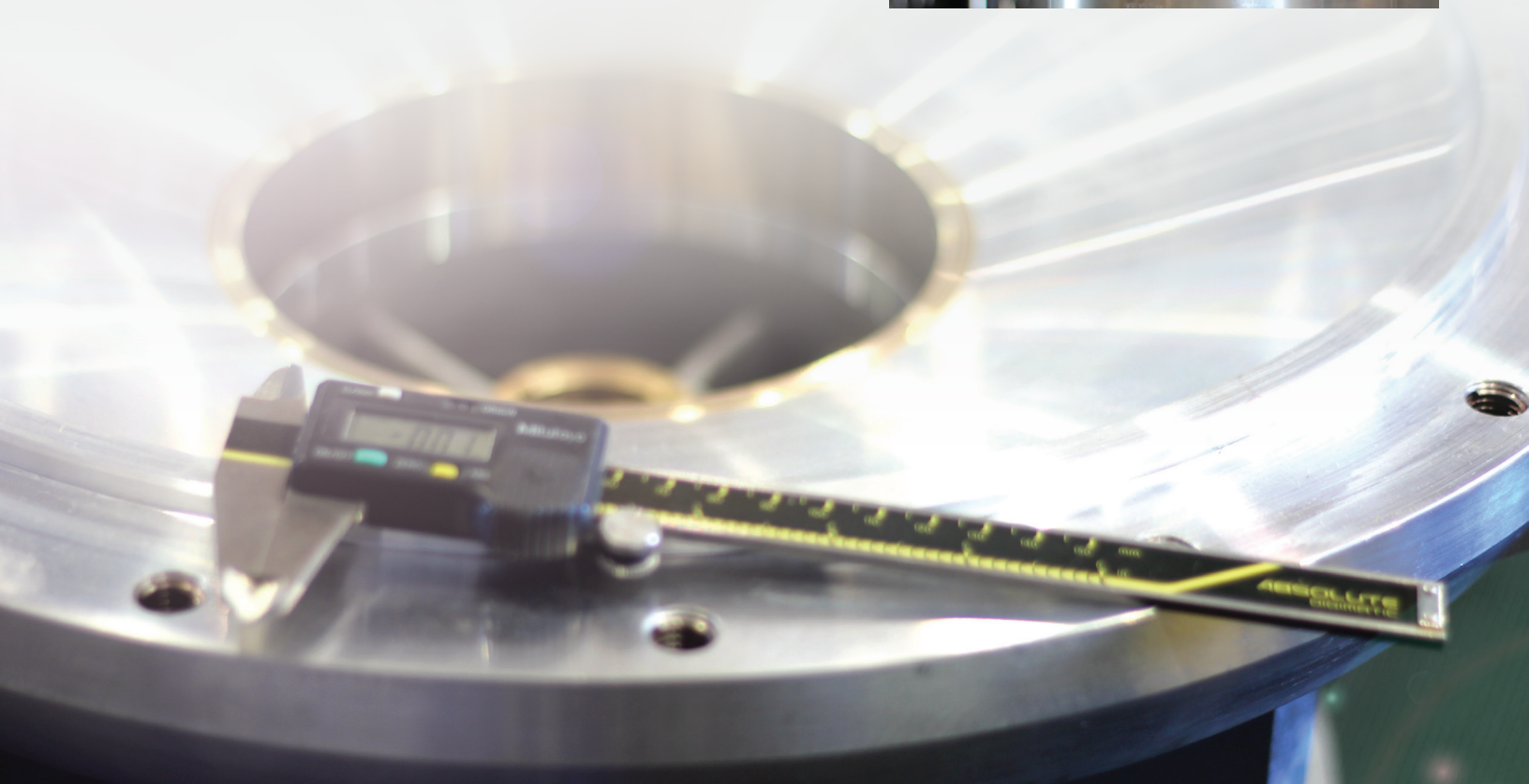
Submerged Motor Pump Design Provided High Level of Safety

With the motor submerged in the pumped fluid, where no oxygen is present during operation, the submerged motor pump design provided by Nikkiso Cryo provides the highest level of safety.

The design uses a common shaft between the motor and the pump section that removes the need for a rotating seal, which eliminates the possibility of hazardous gases leaking into the atmosphere.

In addition, the terminal header, which provides connections for the power cables to penetrate through a static seal from the pumped fluid to the external conduit section, is certified for use in hazardous areas for the safest installation possible.





Innovative Systems

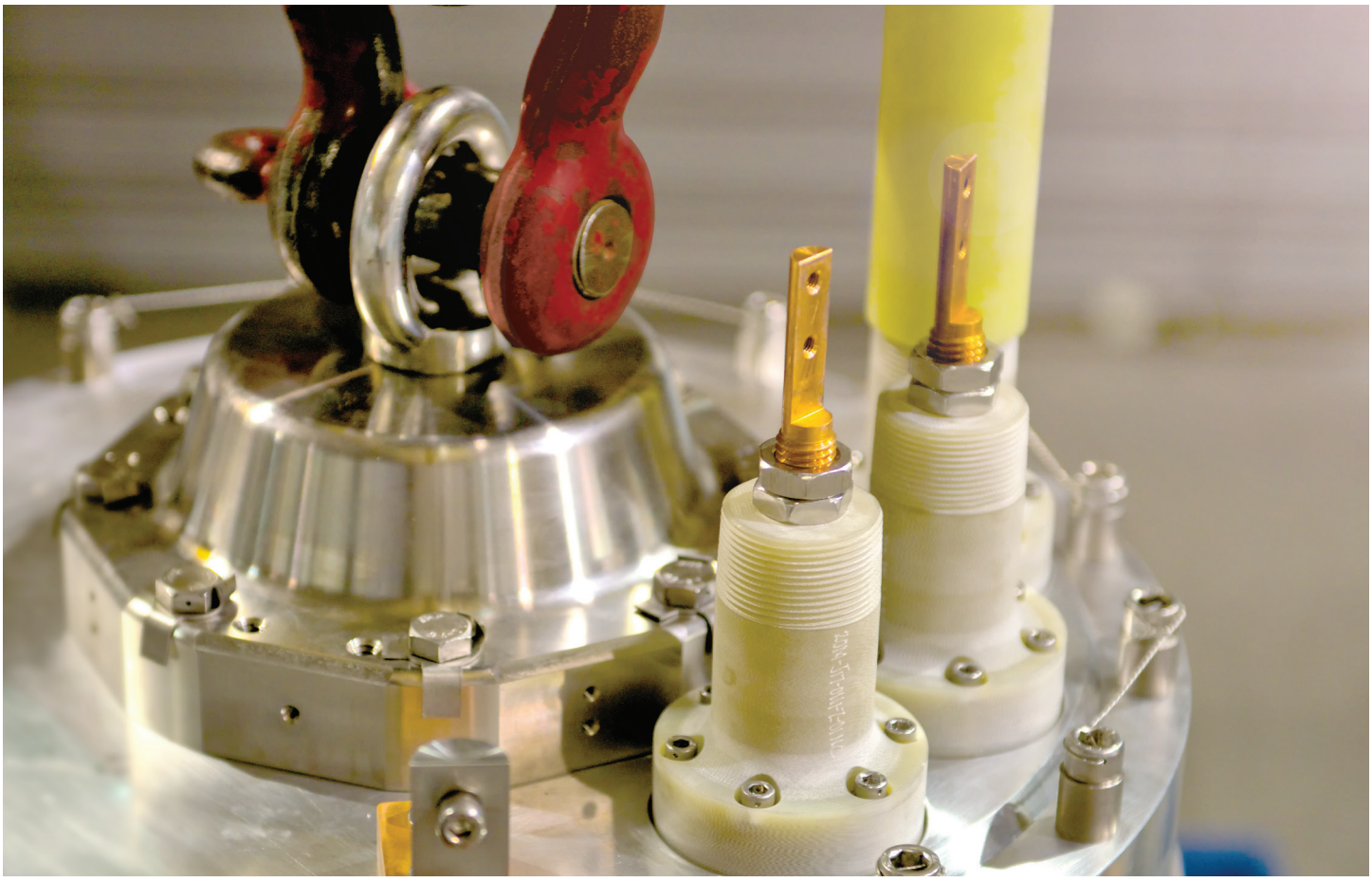
Vibration Systems

As a result of our research and development team and through our Aftermarket Service organization, operating personnel can be trained to interpret data acquired from the condition monitoring system. Nikkiso Cryo's research and extensive experience allows for correlation of monitoring specific vibration modes with specific operating and wear conditions. Condition monitoring and trend analysis has the potential to provide more complete diagnostic information on an operating pump than physical inspection of the disassembled pump. This facilitates optimum timing of maintenance considering factors of reliability, operation and costs. Condition monitoring permits scheduling maintenance only when essential and indicates the need for immediate maintenance to prevent outages and loss of production.

Monitoring Pump vibration is an excellent means to determine pump condition; however, this is particularly challenging for submerged motor cryogenic pumps which have no exposed surfaces or shaft for making direct measurements from the outside of the containment vessel. Nikkiso Cryo can supply piezoelectric accelerometers designed for use directly submerged in the pumped liquid, mounted on the pump housings, and can also locate accelerometers on the outside of suction vessel mounted pumps to provide monitoring of pump vibration. These sensors can measure pump acceleration vibration directly and, with signal conditioning, provide velocity and displacement amplitude data. The condition of internal parts and the extent of wear can be determined by trend monitoring and frequency analysis.

Electrical Systems

As a supplier of submerged motor pumps operating in hazardous environments, Nikkiso Cryo has extensive experience in the selection and design of the proper electrical components to ensure a safe and certified system. These systems can be purged with nitrogen gas to remove moisture from the boundary section between cold and warm, and the purge gas pressure can also be monitored to determine if leakage exists. Electrical systems are supplied to meet plant specifications as well as US, European and any other international codes as required. The systems supplied by Nikkiso Cryo are of the highest quality and are fully tested prior to shipment to ensure the highest level of reliability.



Testing and Reliability

Nikkiso Cryo offers performance testing at full speed, power and flow using LNG, LPG or LN_2 at our facility in Las Vegas, Nevada, or in Miyazaki, Japan. The pumps undergo rigorous testing throughout the flow range, with flow, pressure, motor power and many other measurements taken using calibrated systems to ensure compliance with project requirements.

NPSH as well as complete pumpdown can be measured as well as axial shaft position to ensure the thrust balance system is performing as designed.

Testing is performed to very strict Nikkiso Cryo standards in addition to API, ASME and other international standards and project requirements. Factory performance testing ensures that each and every pump meets exacting standards and provides trouble-free performance once it has been installed and is operating at the customer's site.

Reliability – Second to None

As a result of unique design features that control bearing loads and our multiple bearing technology, Nikkiso Cryo pumps provide unparalleled reliability. In many cases, mean time between overhauls **exceeds 20,000 hours**, with some pumps recording **more than 40,000 hours**.

Global Service and Innovation

Nikkiso Cryo Global Services

- Installation, commissioning and repair
- Technical training
- Spare parts management
- Engineering, failure analysis
- Retrofit of pumps to improve NPSHR and Efficiency performances.

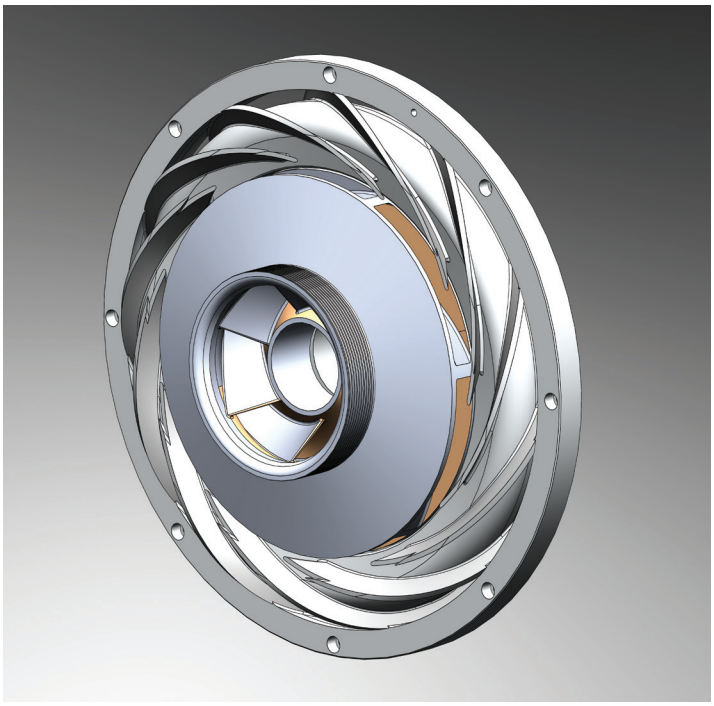
With field service staff located in the USA and Japan, and with the support of our factory engineering staff, Nikkiso Cryo is focused on responding to all service needs with a sense of urgency and commitment. We recognize that downtime at our customers' sites results in losses of productivity and revenue, and we strive to provide the most prompt and efficient service possible.

Our experienced Aftermarket Services Group can provide all of your service needs, with supervisory services from initial installation, commissioning, maintenance, repairs and training, to assist with spare parts management and operational procedure review.

Our aftermarket engineering can improve old design pumps to the state of the art performances of the most modern pumps, by proposing ad-hoc retrofits to implement the high suction capacity Zen inducer, and/or high efficiency continuous cross over radial diffusers.

Nikkiso Cryo Innovation

- Exclusive horizontal assembly process for large, multistage high pressure pumps, reducing the need for specialized pump maintenance facilities at the job site.
- Multiple bearing technology for multistage high pressure pumps to ensure rotor dynamic stability and unsurpassed reliability.
- Pioneer of first high pressure vaporizer feed pumps for FSRU's with more marine and offshore high pressure pumps built than any other competitor by far.
- Specially developed ZEN™ spiral inducers to provide extremely low pumpdown characteristics.



Ongoing service from monitoring pump operating to field service and maintenance.

Nikkiso Cryo now services and supplies parts for:

JC Carter

Global Network

Algeria
Australia
Austria
Belgium
Brunei
China
Egypt
France
Germany
India
Indonesia
Japan
Kuwait
Malaysia
Mexico
Netherlands
Philippines
Portugal
Qatar
Russia
S. Korea
Singapore
Spain
Taiwan
Thailand
U.A.E.
United Kingdom
United States
Vietnam

Nikkiso Clean Energy & Industrial Gases Worldwide Loc

ations


Nikkiso CE&IG GmbH
Finland
Nikkiso CE&IG GmbH
Turkey
Nikkiso CE&IG
Korea
Nikkiso
Miyazaki, Japan
Nikkiso Co. Ltd.
Japan (Headquarters)
Cryogenic Industries/Cryoquip
China
Taikkiso Co. Ltd.
Taiwan
Nikkiso Cosmodyne
India
Nikkiso CE&IG
Vietnam
Nikkiso CE&IG (SEA)
Malaysia
Cryogenic Industries
UAE
Nikkiso CE&IG
Qatar
Cryoquip
Australia
Cryogenic Industries
Egypt
Nikkiso CE&IG
Auckland, New Zealand
Nikkiso CE&IG
South Africa

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