



KELVIN
INTERNATIONAL



Cryogenics For the US Navy

A. Guerra, M. Byrd, P. Guerra, J. Sherwood, A. Yachem
September 2024

Kelvin International Corporation - Facts

Corporate:

Virginia Based Corporation since 1993

CE Marked Products

ISO9001:2015 Certified

SEMI S2/8/10/14/22 Certified

ITAR Compliant

ASME Section VIII, U / UM / R Certified

American Bureau of Shipping ABS – Type Approval

Core Technology:

LN₂ and LOX Generators

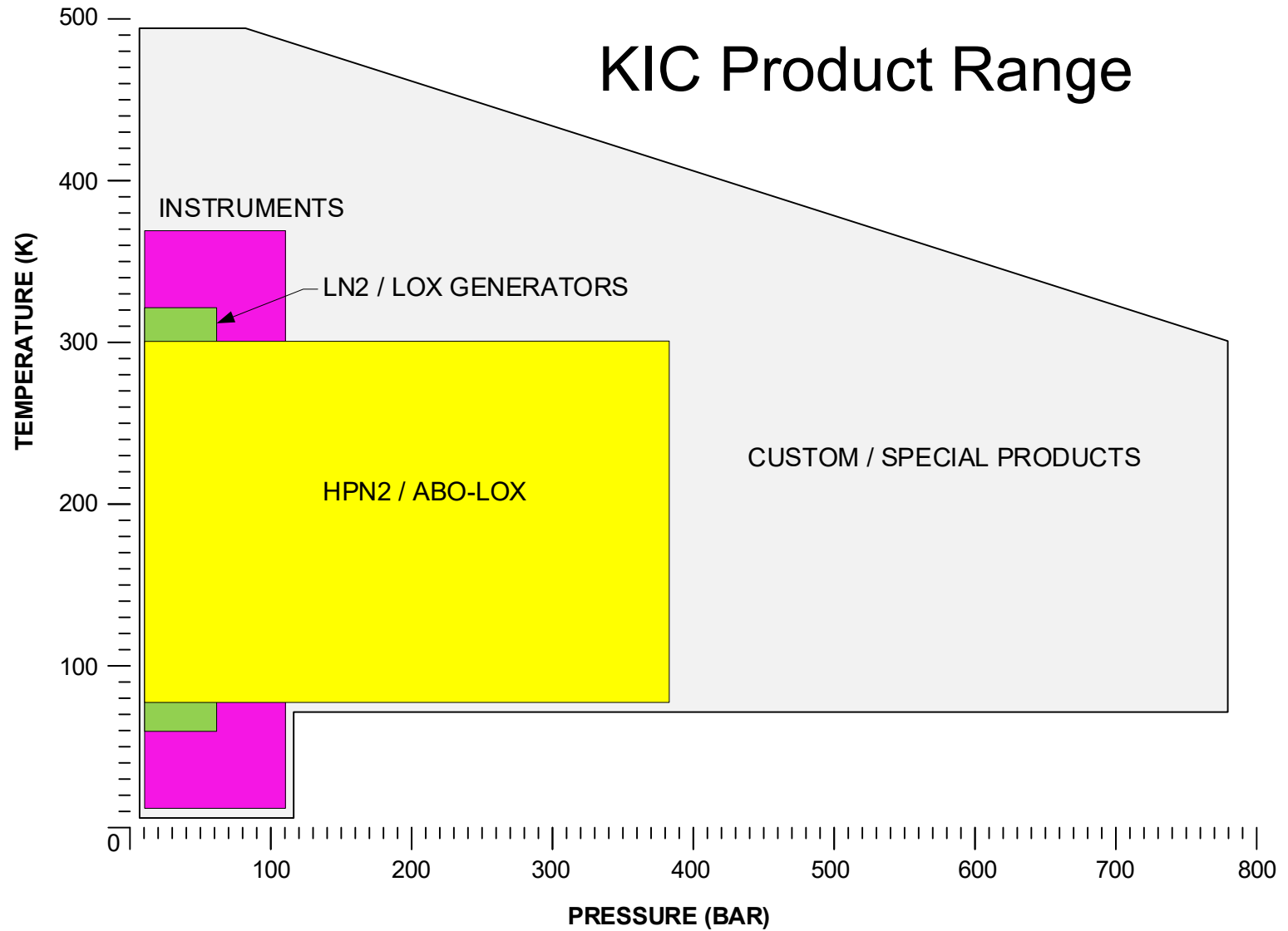
Cryogenic Instruments and Controls – From PCB Level

Cryogenic Converters for the US Navy

LOX Service (Maintenance) Provider for the US Government



KELVIN
INTERNATIONAL



Problem Statement – Fill Sub Flasks Quickly

Option One - Cylinder banks on a delivery truck:

Hard to move around the pier and must use a long hose. Tanker arrives with 700 bar and leaves with a 350 bar charge. Requires driver to have access to pier and to operate the banks.

Option Two – High Pressure Compressor:

Unreliable and maintenance intensive process that can contaminate the Nitrogen. These are for permanent installations (say Aircraft carrier) and NEVER at the pier. The filling process may take many hours to complete.

Option Three – The KIC HPN2:

Portable, reliable and takes only minutes to hours to perform the fill. The purity is guaranteed by the LN₂ product quality and pre-testing.

Note:

Same benefits apply to applications for Cylinder Filling Stations located at the base N2-Shop / Diving Locker / Flightline

Portable HPN2 – Base and Road Worthy

160 m³ / hr at 350 bar - Pier Side



970 m³ / hr at 350 bar – Road Travel



Attack Boats

Missile Boats



Solution – Benefits of the HPN2 and HPO2

Efficiency:

190 kW will provide 800 m³ per hour of room temperature GN₂ at 380 bar
Approximately \$200 in electrical power and \$600 in LN₂ per hour of operation.

Cost to Own:

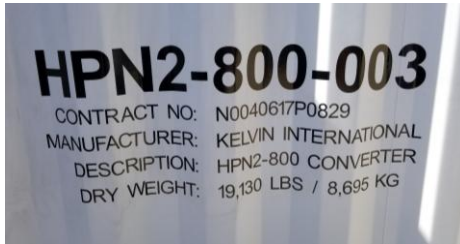
The HPN2 will operate several years (some up to two decades) with very little maintenance. The worst news is a \$30K pump cold end repair.

Operator Requirement:

The HPN2 was a common tool used by the Navy as they ran a *very good* Cryogenic School Program. Very few qualified sailors are currently available. KIC has to train (certify) the operators and commit to service contracts.

Solution: Make it Sailor-proof. More wil follow.....in this Presentation

Deployable HPN2 – Base and Road Worthy



970 m³ / hr at 350 bar with 800-Gallon Tank
Tested and Rolled Inside an ISO-20 Container



How Does the HPN2 Work?

Engineers Can Stay

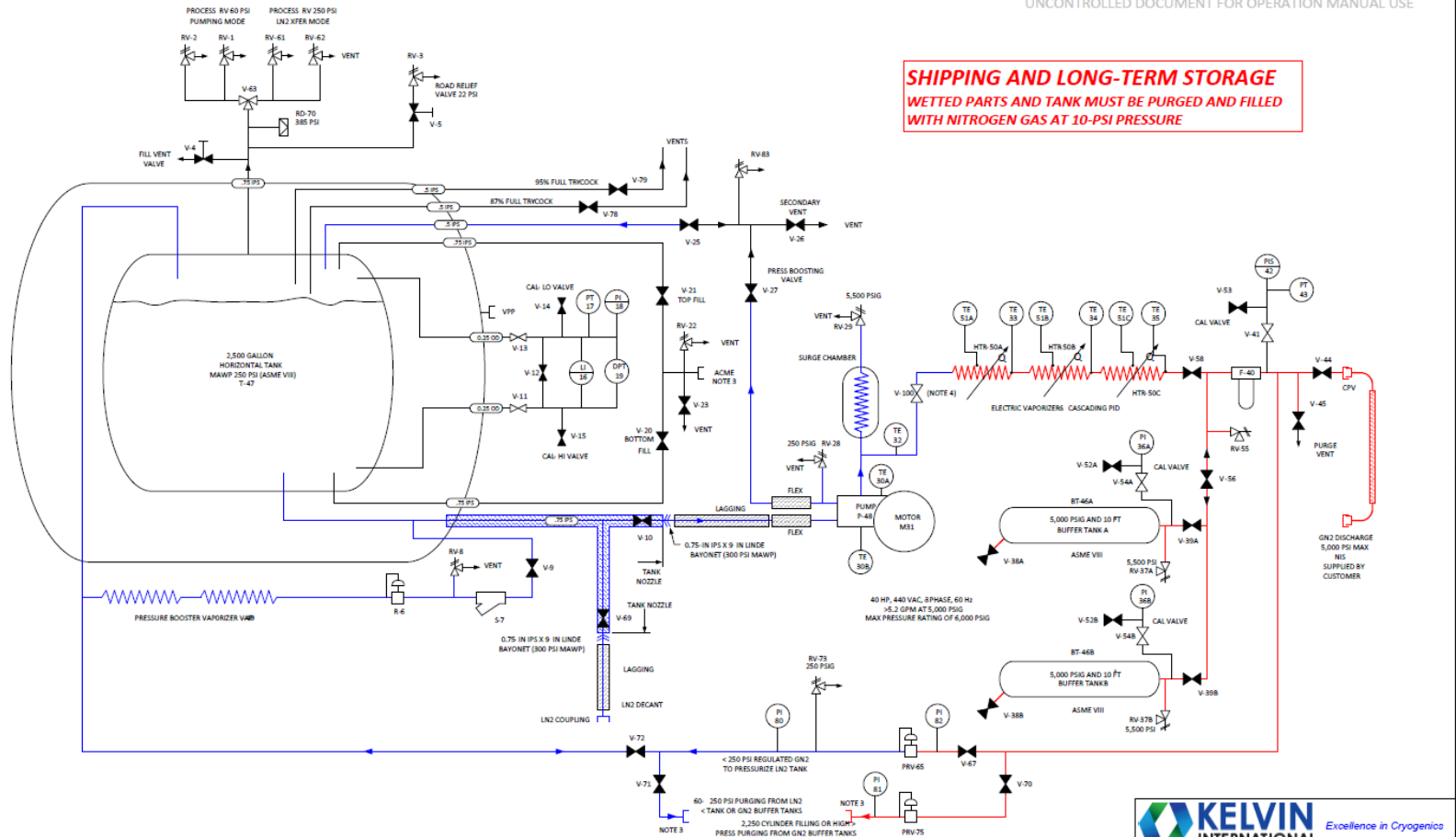
All Others Can Take a Coffee Break

Questions are Welcomed



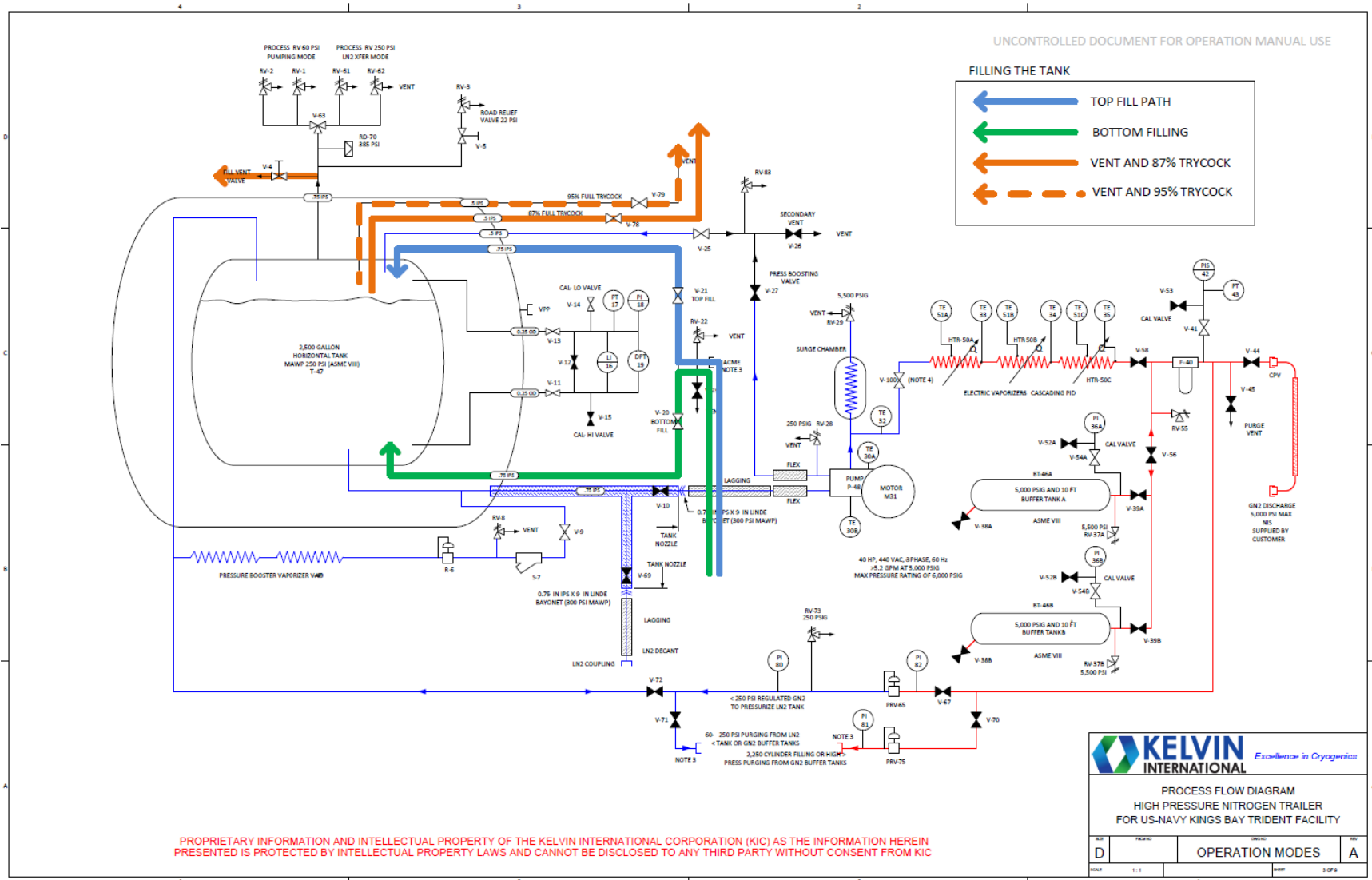
UNCONTROLLED DOCUMENT FOR OPERATION MANUAL USE

SHIPPING AND LONG-TERM STORAGE
WETTED PARTS AND TANK MUST BE PURGED AND FILLED
WITH NITROGEN GAS AT 10-PSI PRESSURE



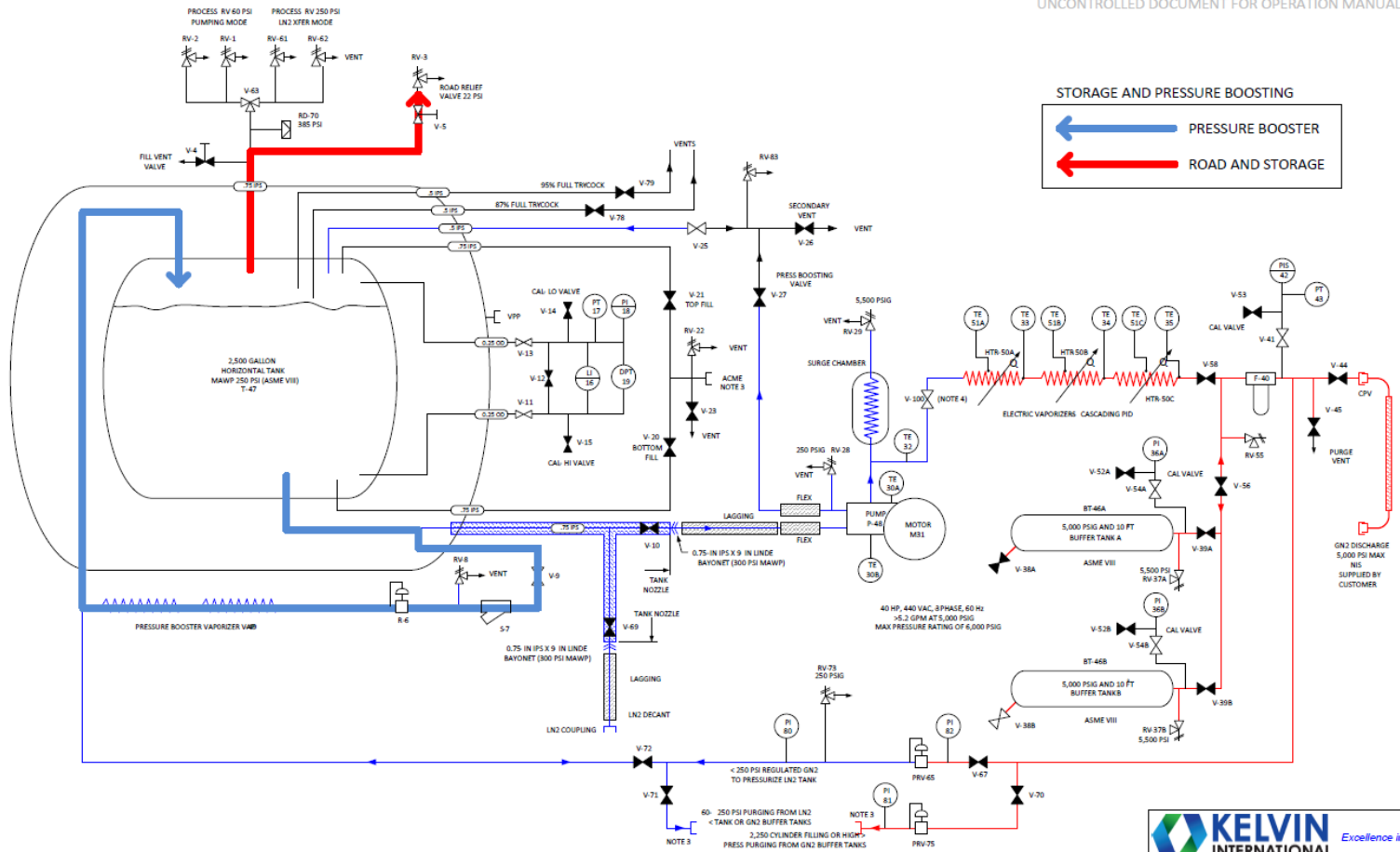
PROPRIETARY INFORMATION AND INTELLECTUAL PROPERTY OF THE KELVIN INTERNATIONAL CORPORATION (KIC) AS THE INFORMATION HEREIN PRESENTED IS PROTECTED BY INTELLECTUAL PROPERTY LAWS AND CANNOT BE DISCLOSED TO ANY THIRD PARTY WITHOUT CONSENT FROM KIC

		KELVIN INTERNATIONAL		Excellence in Cryogenics	
PROCESS FLOW DIAGRAM HIGH PRESSURE NITROGEN TRAILER FOR US-NAVY KINGS BAY TRIDENT FACILITY					
REV	DESCRIPTION		REV	DESCRIPTION	
D	OPERATION MODES		A		
SCALE	1:1		DATE	06/08	



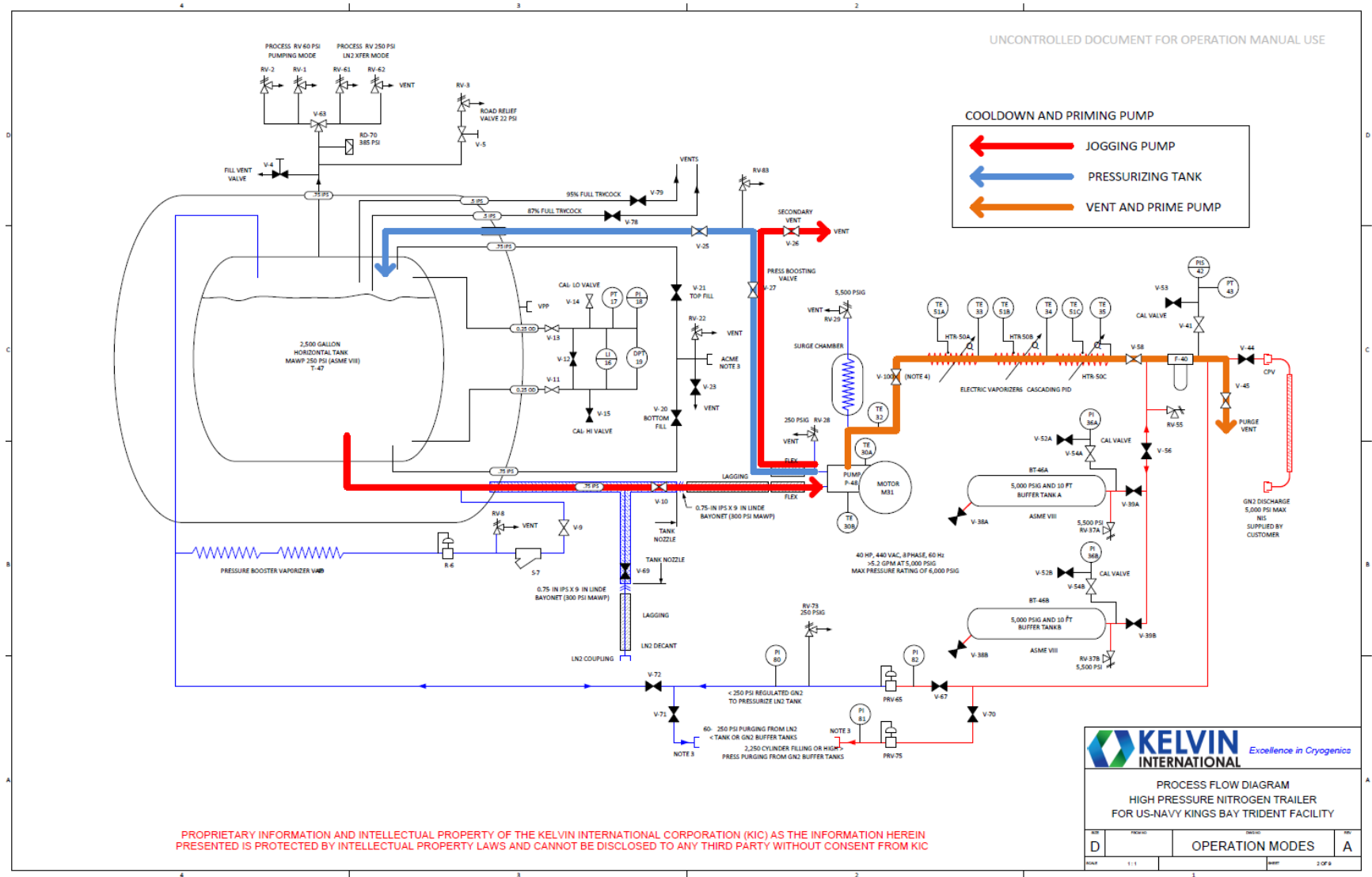


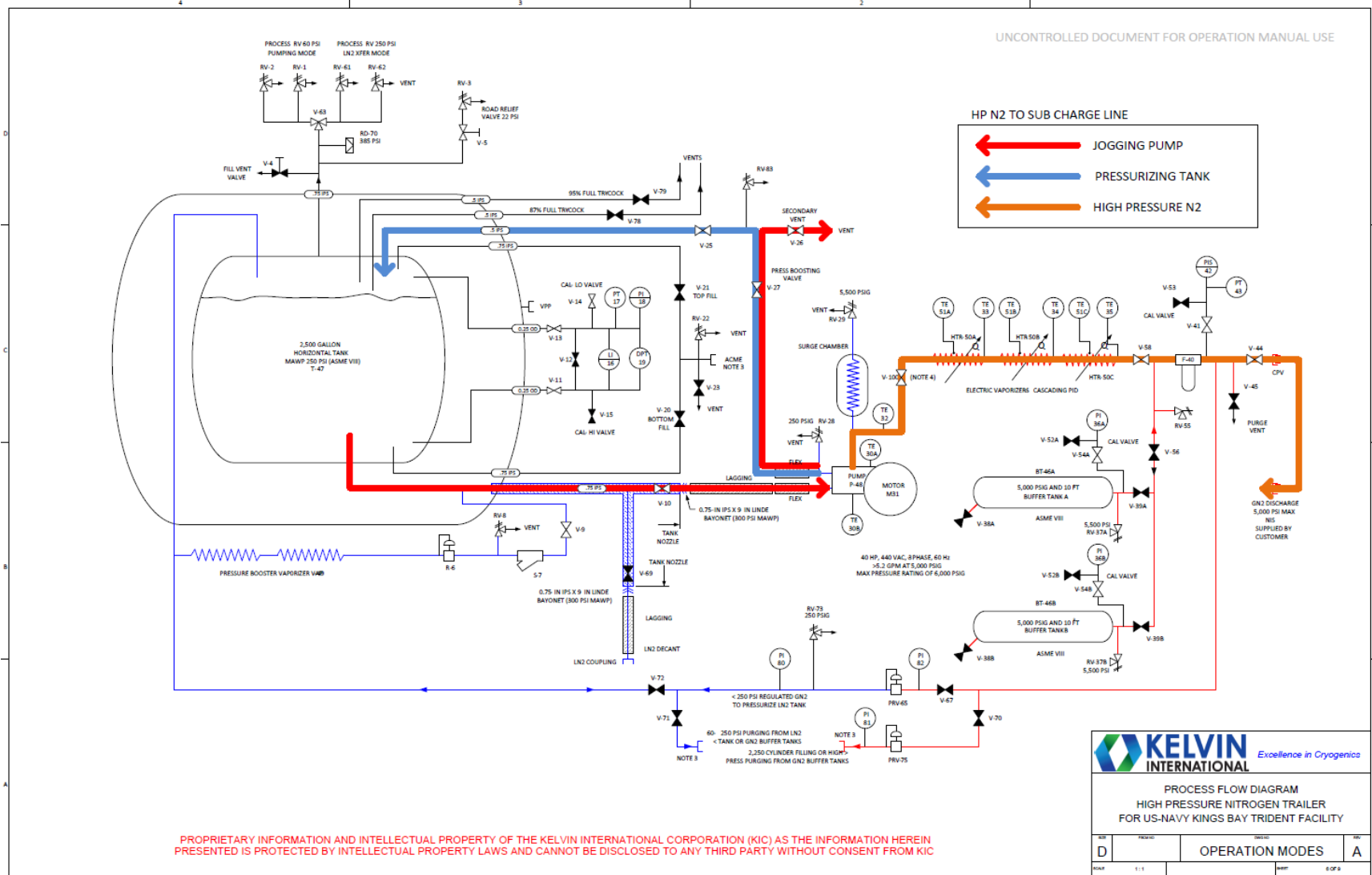
UNCONTROLLED DOCUMENT FOR OPERATION MANUAL USE

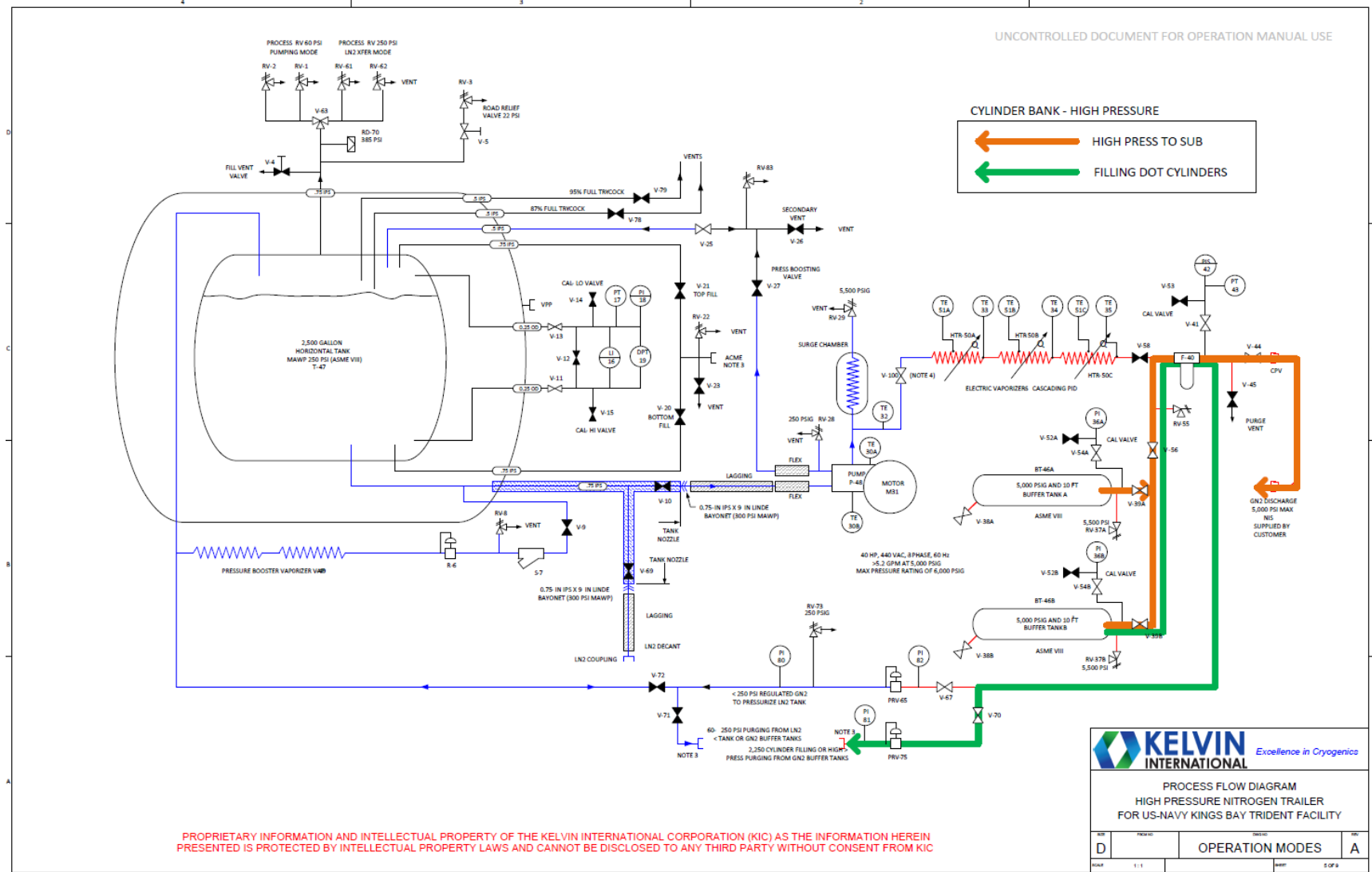


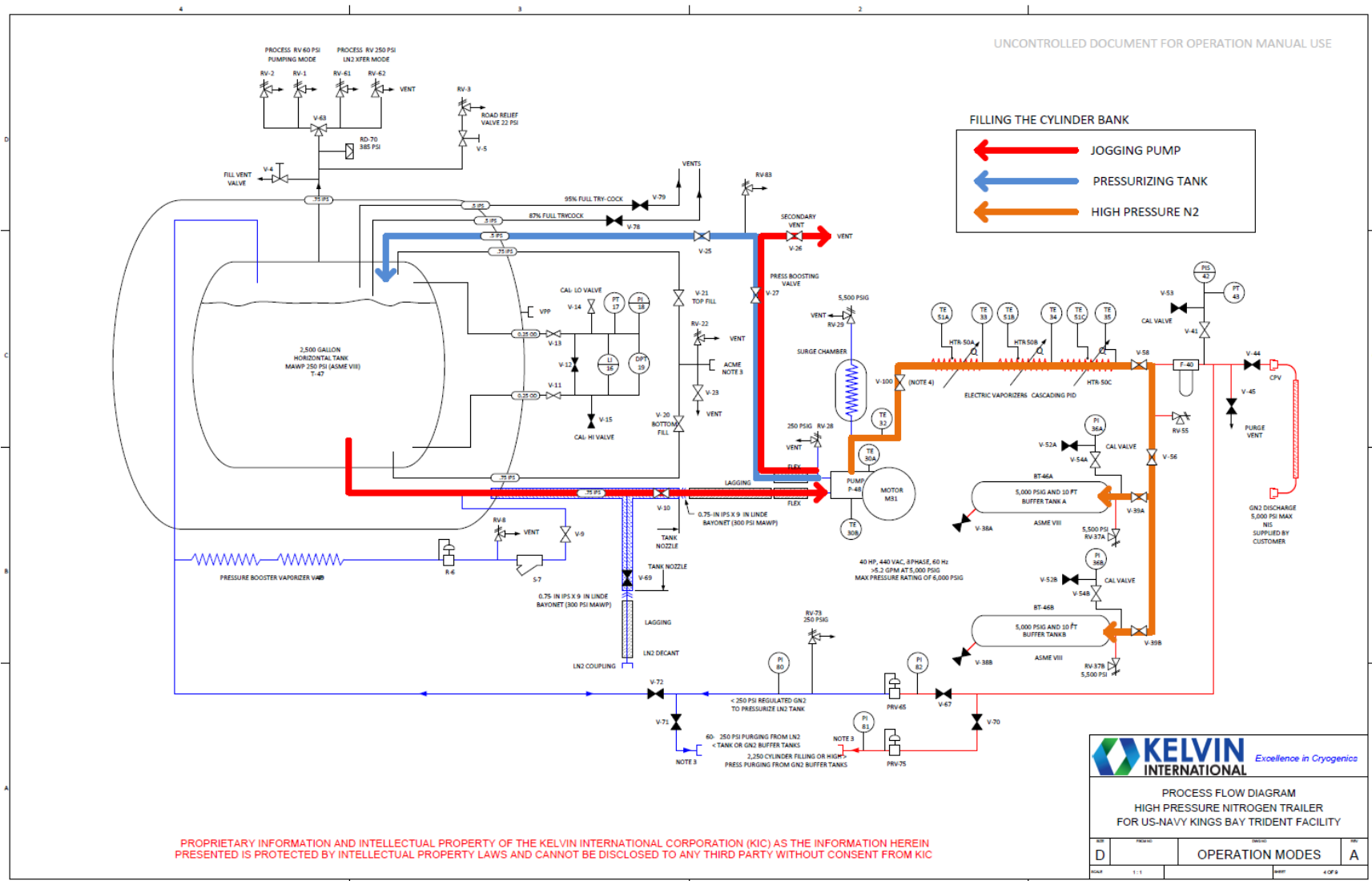
PROPRIETARY INFORMATION AND INTELLECTUAL PROPERTY OF THE KELVIN INTERNATIONAL CORPORATION (KIC) AS THE INFORMATION HEREIN PRESENTED IS PROTECTED BY INTELLECTUAL PROPERTY LAWS AND CANNOT BE DISCLOSED TO ANY THIRD PARTY WITHOUT CONSENT FROM KIC

KELVIN INTERNATIONAL <i>Excellence in Cryogenics</i>		
PROCESS FLOW DIAGRAM HIGH PRESSURE NITROGEN TRAILER FOR US-NAVY KINGS BAY TRIDENT FACILITY		
REV D	REVISION	DATE 1-1-1
OPERATION MODES		REV A
1		1 OF 8





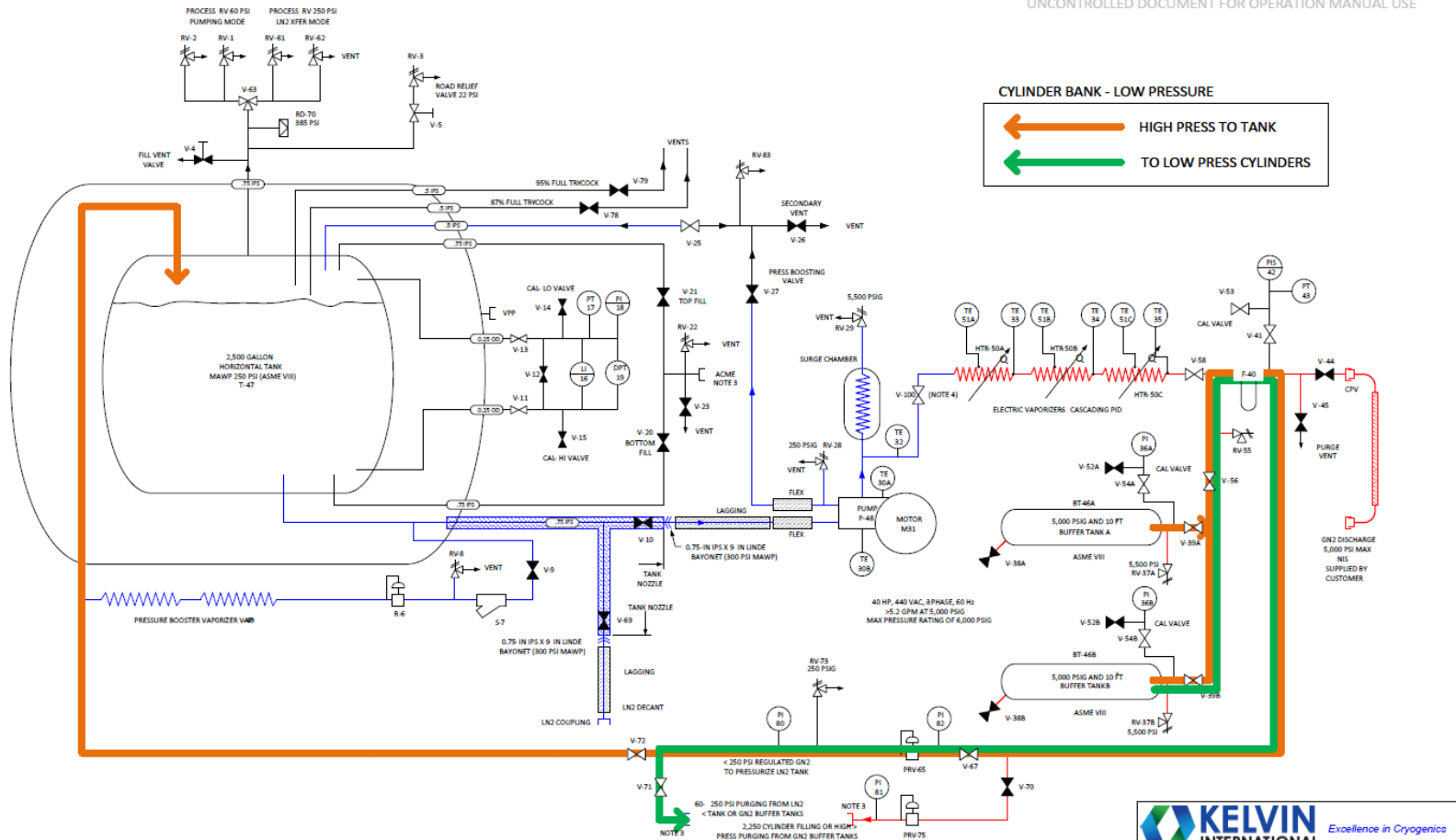






UNCONTROLLED DOCUMENT FOR OPERATION MANUAL USE

CYLINDER BANK - LOW PRESSURE



PROPRIETARY INFORMATION AND INTELLECTUAL PROPERTY OF THE KELVIN INTERNATIONAL CORPORATION (KIC) AS THE INFORMATION HEREIN PRESENTED IS PROTECTED BY INTELLECTUAL PROPERTY LAWS AND CANNOT BE DISCLOSED TO ANY THIRD PARTY WITHOUT THE CONSENT FROM KIC



PROCESS FLOW DIAGRAM
HIGH PRESSURE NITROGEN TRAILER
FOR US-NAVY KINGS BAY TRIDENT FACILITY

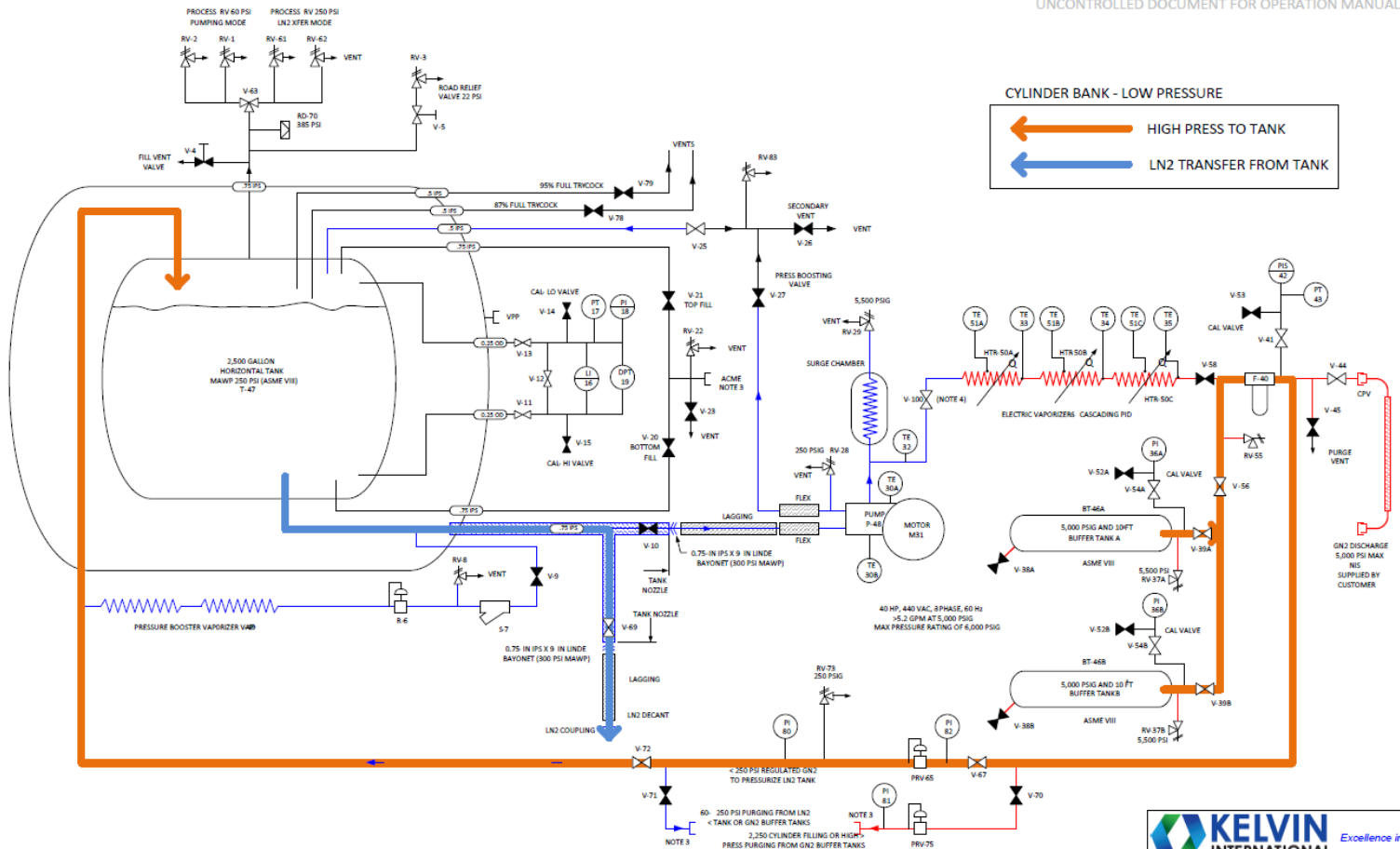
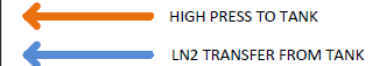
REV	DESCRIPTION	DATE	BY
D	OPERATION MODES		A

SCALE 1:1 SHEET 7 OF 9



UNCONTROLLED DOCUMENT FOR OPERATION MANUAL USE

CYLINDER BANK - LOW PRESSURE



PROPRIETARY INFORMATION AND INTELLECTUAL PROPERTY OF THE KELVIN INTERNATIONAL CORPORATION (KIC) AS THE INFORMATION HEREIN PRESENTED IS PROTECTED BY INTELLECTUAL PROPERTY LAWS AND CANNOT BE DISCLOSED TO ANY THIRD PARTY WITHOUT CONSENT FROM KIC

KELVIN
INTERNATIONAL

Excellence in Cryogenics

PROCESS FLOW DIAGRAM
HIGH PRESSURE NITROGEN TRAILER
FOR US-NAVY KINGS BAY TRIDENT FACILITY

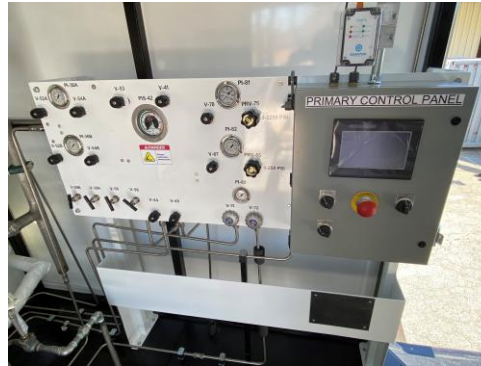
REV	DESCRIPTION	DATE	BY
D	OPERATION MODES	A	

1 of 1

Sailor-Proof Ergonomics / Safety is Important



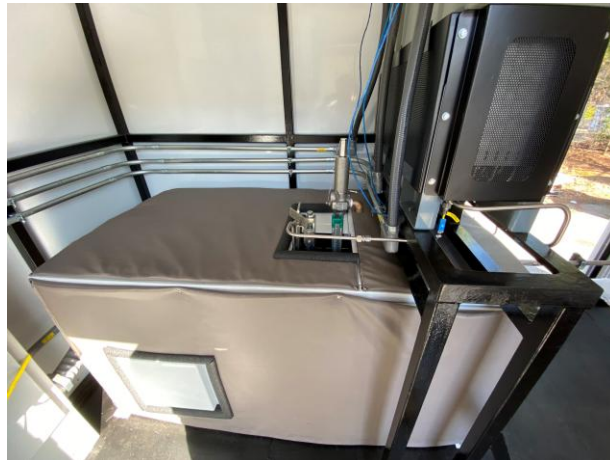
Additional HMI on Pedestal



Controls With Proper Access



Clear Space Avoiding Trip Hazards



Sound Proofing Applied to the Cryo Pump

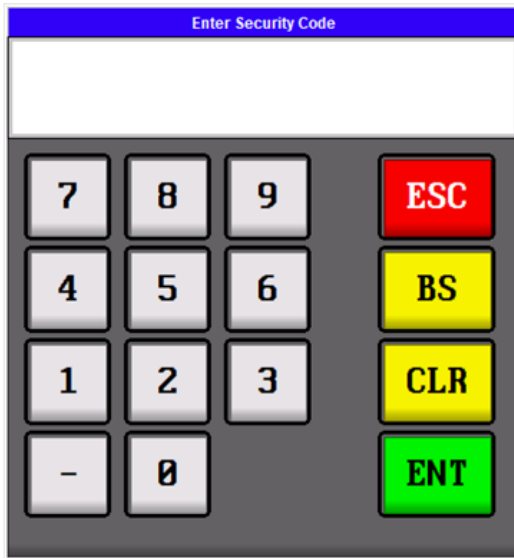


Touch-Safe 54 kW Heaters



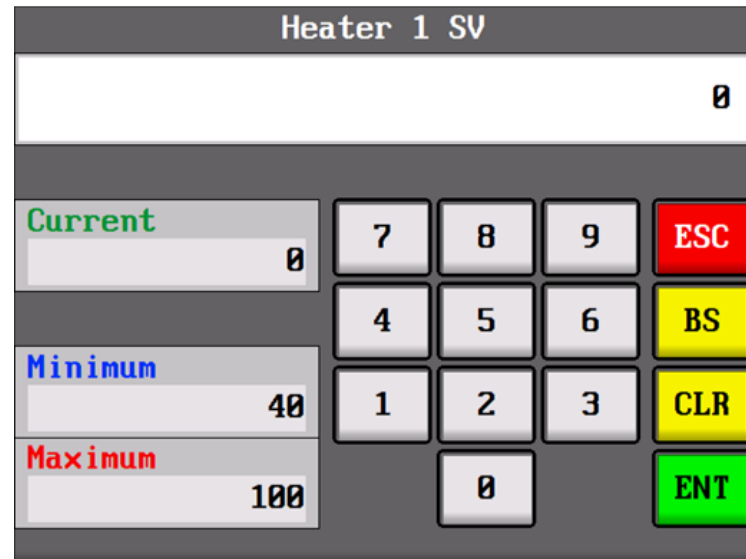
Valve Cluster for Fill and Prime

Sailor-Proofing – Keep the Amateurs Away



Enter Security Code

7	8	9	ESC
4	5	6	BS
1	2	3	CLR
-	0		ENT



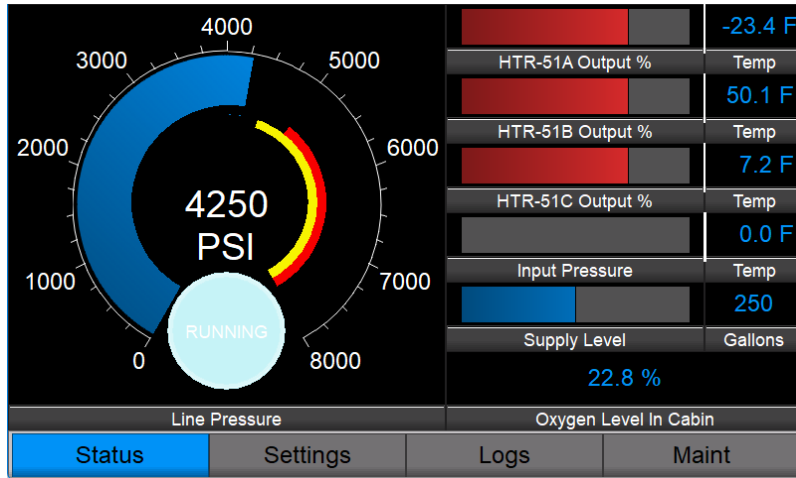
Heater 1 SV

0

Current	0	7	8	9	ESC
		4	5	6	BS
Minimum	40	1	2	3	CLR
Maximum	100	0			ENT

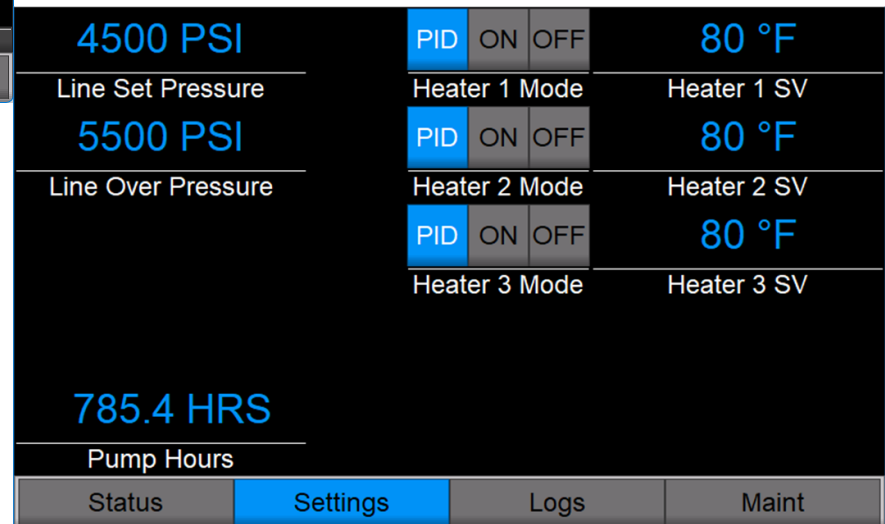
Must Have Proper KIC Training and Codes to Operate the HPN2

Sailor-Proof KISS Just Enough Information



Simple Dashboard

Peek at the Heaters to be Sure





Sailor-Proofing – Smart Bells and Whistles

<u>ODH ALARM SETTINGS</u>				<u>SELECT PAGE</u>
No  Yes	19.5 %		18.5 %	MACHINE SETTINGS
ODH Installed	O2 Alarm Level	O2 Critical Level	SUPPLY SETTINGS	
No  Yes	No  Yes	STACKLIGHT SETTINGS		
Start Fans On Alarm	Start Fans On Critical	ODH SETTINGS		

Must Have Proper KIC Training and Codes to Operate the HPN2

Sailor-Proofing – Additional Factory Settings

SUPPLY SETTINGS			SELECT PAGE	
No  Yes	25.0 PSI	250 Gal	MACHINE SETTINGS	
Tank Installed	Supply Pressure Alarm	Supply Level Low	SUPPLY SETTINGS	
TANK SETTINGS			STACKLIGHT SETTINGS	
Advanced 	0.045533	1.254680	ODH SETTINGS	
	X^3 Coefficient	X^2 Coefficient		
Simple 	-0.21856	X Coefficient		
Volume	Offset			

Machine Flexibility

Heater 1 Installed	Heater 2 Installed	Heater 3 Installed	Inverter Drive	Door Override	SELECT PAGE	
Yes 	Yes 	Yes 	Yes 	Yes 	MACHINE SETTINGS	
No 	No 	No 	No 	No 	SUPPLY SETTINGS	
					STACKLIGHT SETTINGS	
					ODH SETTINGS	
4500 PSI		275.0 °F				
Line Setpoint		Heater Core Alarm				
5000 PSI						
Line Over						
Status		Settings		Logs		Maint

Custom Configuration Control

STACK LIGHT SETTINGS					SELECT PAGE	
No 	NOTES: RED LIGHT ALWAYS FLASHES AND INCLUDES AUDIBLE ALERT. FLASHING TAKES PRECEDENCE OVER SOLID				MACHINE SETTINGS	
Stacklight Installed					SUPPLY SETTINGS	
GREEN LIGHT (SOLID)	GREEN LIGHT (FLASHING)	YELLOW LIGHT (SOLID)	YELLOW LIGHT (FLASHING)	RED LIGHT (FLASHING)	STACKLIGHT SETTINGS	
ODH CRITICAL	ODH CRITICAL	ODH CRITICAL	ODH CRITICAL	ODH CRITICAL	ODH SETTINGS	
ODH ALERT	ODHALERT	ODHALERT	ODHALERT	ODHALERT		
OVER PRESSURE	OVER PRESSURE	OVER PRESSURE	OVER PRESSURE	OVER PRESSURE		
ALARM	ALARM	ALARM	ALARM	ALARM		
RUNNING	RUNNING	RUNNING	RUNNING	RUNNING		
READY	READY	READY	READY	READY		
NONE	NONE	NONE	NONE	NONE		

ODH Safety and Operation Warnings

Alarm Summary				Total of 0 Alarms		Pressure Logs	
Message	Confirm	Activated	Confirmed	Deactivated	Temp Logs		
							Alarm Logs
Page Up	Page Down	Line Up	Line Down	Detail	Clear All	Confirm	Confirm All
Status		Settings		Logs		Maint	

Datalogging Operations and Performance

Shipboard and Pier Side HPN2



Works with Companion ISO Tank
or Commercial Trailer Tanker
Internal 400 bar Storage Vessels

Pier / N2 Shop HPN2 – Stays on Base



800 m³ / hr at 350 bar with 1000-Gallon Tank
Wagon with Steerable front Axle for Tight Spaces



Filling Cylinders for Surface Ships
N2 Shop Applications



Oddballs and Orphans for Sub-Bases



150 m³ / hr at 350 bar with 300 to 1000-Gallon Tanks
Pier Electric Power or On-Board Diesel Generator



Static Converters – LN₂ and ABO LOX



Very Analog and 50's Design with Modern Parts
KIC On Contract to Manufacture and Test 102 units
Tanks are 100% SSTL and Made to KIC's Requirements

Static Converters – LN₂ and ABO LOX



Pump Skid is Manufactured in Newport News
All is Oxygen Cleaned to MIL-STD-1330-E Requirements
Each CSS Assembly Requires 18-21 days of Performance Testing



What Else Does KIC do....



Make LN_2 as Easy as Tap Water

Make LOX, LNG, LHe....

COGS-KLOX Generator for ABO LOX



Where does the ABO LOX Come From?

Any Questions?

