SPECIFICATION FOR

20,000 GALLON

LIQUID NITROGEN STORAGE TANK

D-ZERO PROJECT

FERMILAB

G. T. MULHOLLAND

G. STEPANEK

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LIQUID NITROGEN STORAGE TANK SPECIFICATION

1.0 SCOPE

1.1 THIS SPECIFICATION DEFINES THE REQUIREMENTS FOR A LIQUID NITROGEN STORAGE TANK TO BE INSTALLED AT FERMILAB,BATAVIA ILLINOIS.

2.0 TANK DATA

2.1 P & I DIAGRAM ---------- DWG. 3740-MC-222396

2.2 CONFIGURATION ---------- 10 FT DIA, HORIZ

2.3 CAPACITY

2.3.1 WATER VOLUME ---------- 20,000 GALLONS

2.3.2 LIQUID NITROGEN VOLUME AT TRYCOCK - 19,000 GALLONS

2.4 MAXIMUM ALLOWABLE WORKING PRESSURE ------ 65 PSIG,VACUUM

2.5 MINIMUM ALLOWABLE TEMPERATURE ---------- -320 DEG F

2.6 REQUIRED DISCHARGE CAPACITY

2.6.1 ---------- 40 GPM MAX

2.6.2 ---------- 20 GPM NOM

2.7 REQUIRED TANK OPERATING PRESSURE -------- 30 PSIG

2.8 OPERATION ---------- CONTINUOUS

2.9 FILLING

2.9.1 ---------- FROM COMMERCIAL HIGHWAY TRANSPORT

2.10 NORMAL EVAPORATION RATE ----- NOT TO EXCEED 0.30% OF CAPACITY PER DAY AT 50 MILLITORR VACUUM

2.11 MOUNTING ----- TWO SADDLES OR FOUR LEGS, WITH PROVISION FOR ANCHOR BOLTS, FOR INSTALLATION ON BUYERS CONCRETE PIERS.

2.12 HANDLING PROVISIONS ---- LIFTING LUGS TO PERMIT LIFTING TANK INTO PLACE. ANY SPECIAL SPREADER BARS REQUIRED SHALL BE FURNISHED WITH TANK.

2.13 PAINT ---- ALL EXTERIOR CARBON STEEL SURFACES TO BE SUITABLY PRIMED AND FINISHED WITH WHITE POLYURETHANE ENAMEL - DUPONT IMRON OR EQUAL.

3.0 TANK DESIGN

3.1 TANK SHALL BE CONVENTIONAL DOUBLE-WALL CRYOGENIC TANK WITH EVACUATED PEARLITE INSULATION.

3.2 INNER VESSEL SHALL BE BUILT AND STAMPED IN ACCORDANCE WITH THE ASME PRESSURE VESSEL CODE, SECTION VIII, DIVISION 1, FOR THE M.A.W.P. IN 2.4 ABOVE, AND M.A.T. IN 2.5 ABOVE, AND SHALL BE REGISTERED WITH THE NATIONAL BOARD.

3.3 OUTER VESSEL (VACUUM JACKET) SHALL BE OF STEEL, DESIGNED FOR FULL VACUUM INTERNAL WITH A SAFETY FACTOR NOT LESS THAN TWO (MINIMUM COLLAPSE PRESSURE OF 30 PSI).

3.4 PIPING

3.4.1 PIPING CONNECTING TO THE INNER VESSEL IN THE VACUUM SPACE SHALL BE OF WELDABLE 300 SERIES STAINLESS STEEL, AND SHALL BE FORMED FROM CONTINUOUS LENGTHS OF PIPE OR TUBING TO THE MAXIMUM EXTENT PRACTICAL. JOINTS SHALL BE WELDED.

3.4.2 NITROGEN PIPING OUTSIDE THE OUTER VESSEL SHALL BE COPPER, COPPER ALLOYS OR STAINLESS STEEL SUITABLE FOR CRYOGENIC SERVICE. COPPER FITTINGS SHALL BE WROUGHT OR BAR STOCK SOLDER JOINT TYPE. STAINLESS FITTINGS SHALL BE WELD TYPE. VACUUM JACKETED PIPING SHALL BE STAINLESS STEEL.

3.4.3 GAGE CONNECTIONS AND SAFETY DEVICE CONNECTIONS SHALL BE THREADED AND MADE UP WITH OXYGEN-COMPATIBLE THREAD SEALANT. OTHER JOINTS SHALL BE SILVER-BRAZED FOR COPPER OR COPPER ALLOYS, OR WELDED FOR STAINLESS STEEL.

3.4.4 PIPING CONNECTED TO THE INNER VESSEL SHALL INCLUDE

3.4.4.1 TOP TRANSPORT FILL LINE, CONNECTING TO THE VAPOR PHASE, AND HAVING A SPLASH PLATE OR SPRAY HEADER INSIDE THE INNER VESSEL.

3.4.4.2 VENT AND SAFETY RELIEF LINE, CONNECTING TO VAPOR PHASE.

3.4.4.3 BOTTOM FILL LINE, CONNECTING TO THE LIQUID PHASE AND HAVING A DEFLECTOR INSIDE THE INNER VESSEL.

3.4.4.4 PRESSURE BUILD LIQUID FEED LINE AS CLOSE AS POSSIBLE TO THE BOTTOM.

3.4.4.5 PRESSURE BUILD VAPOR RETURN LINE, CONNECTING TO VAPOR PHASE.

3.4.4.6 LIQUID DELIVERY LINE, CONNECTING TO LIQUID PHASE AS CLOSE AS POSSIBLE TO THE BOTTOM.

3.4.4.7 FULL TRYCOCK LINE, HAVING ITS OPENING AT THE 19,000 GALLON LEVEL.

3.4.4.8 TOP GAGE LINE, CONNECTING TO THE VAPOR PHASE.

3.4.4.9 BOTTOM GAGE LINE, CONNECTING TO LIQUID PHASE AS CLOSE AS POSSIBLE TO THE BOTTOM.

3.4.4.10 PRESSURE REGULATING VALVE SHALL BE SU SUPPLIED AS INDICATED ON SCHEMATIC.

3.4.4.11 MANUAL BLOWDOWN VALVE, 1 1/2".

3.4.5 VALVES

3.4.5.1 ALL VALVES SHALL BE SUITABLE FOR THEIR APPLICATION.

3.4.5.2 ALL COLD VALVES SHALL HAVE EXTENDED STEMS AND BONNETS.

3.4.5.3 PNEUMATIC ACTUATORS AND POSITIONERS (FISCHER) SHALL BE SUPPLIED AS INDICATED ON THE SCHEMATIC.

3.5 FILL SYSTEM

3.5.1 A CGA STANDARD 1 1/2" NITROGEN HOSE CONNECTOR SHALL BE PROVIDED.

3.5.2 A FILL CHECK VALVE SHALL BE PROVIDED, INBOARD OF THE HOSE CONNECTOR.

3.5.3 A HOSE SAFETY VALVE AND A HOSE BLOWDOWN VALVE SHALL BE PROVIDED, INBOARD OF THE FILL CHECK VALVE.

3.5.4 INBOARD OF THE HOSE SAFETY AND HOSE BLOWDOWN, THE FILL LINE SHALL TEE OFF TO A TOP FILL VALVE (LEADING TO THE LINE IN 3.4.4.1) AND A BOTTOM FILL VALVE (LEADING TO THE LINE IN 3.4.4.3).

3.6 LIQUID DELIVERY LINE

3.6.1 THE LINE OF 3.4.4.5 SHALL BE EQUIPPED WITH A FULL LINE SIZE VACUUM-JACKETED VALVE AND BAYONET ASSEMBLY

3.6.1.1 THE BAYONET AND VALVE ASSEMBLY SHALL BE CRYO-333 LAB 1 1/2", DWG CV1299, TO MATE WITH PURCHASER'S V-J DISTRIBUTION PIPING.

3.6.2 THE VACUUM SYSTEM OF THE VALVE AND BAYONET ASSEMBLY SHALL BE SEPERATE FROM THE TANK VACUUM SYSTEM.

3.6.3 1/2" AUXILIARY LIQUID WITHDRAWL LINE.

3.7 SAFETY DEVICES

3.7.1 THE INNER VESSEL SHALL BE PROTECTED FROM EXCESSIVE INTERNAL PRESSURE BY A SYSTEM OF TWO SAFETY RELIEF VALVES, TWO RUPTURE DISCS, AND A EXTENDED STEM SELECTOR VALVE WITH ONE SAFETY RELIEF VALVE, AND ONE RUPTURE DISC ON EACH OUTLET OF THE SELECTOR VALVE.

3.7.1.1 THE SELECTOR VALVE SHALL BE SUCH THAT AT LEAST ONE OUTLET IS ALWAYS OPEN TO THE INNER VESSEL.

3.7.1.2 THE CAPACITIES OF EACH SAFETY RELIEF VALVE AND EACH RUPTURE DISC SHALL BE AS REQUIRED BY COMPRESSED GAS ASSOCIATION PAMPHLET S-1.3, OR 2" WHICHEVER IS LARGER.

3.7.2 THE OUTER VESSEL SHALL BE PROTECTED BY RELIEF DEVICES HAVING A DISCHARGE AREA OF AT LEAST 50 SQUARE INCHES AND OPENING AT A PRESSURE NOT MORE THAN THE LESSER OF THE INTERNAL DESIGN OF THE OUTER VESSEL (AS CALCULATED BY THE ASME CODE) OR 15 PSIG.

3.7.3 ALL PIPING SECTIONS IN WHICH LIQUID NITROGEN OR VERY COLD GASEOUS NITROGEN OR COULD BE TRAPPED BY MANUAL OR AUTOMATIC CLOSING OF VALVES SHALL BE PROTECTED BY SUITABLE SAFETY RELIEF VALVES.

3.8 GAGES

3.8.1 THE TANK SHALL BE PROVIDED WITH A DIFFERENTIAL PRESSURE LIQUID LEVEL GAGE, CONNECTED BETWEEN THE TOP AND BOTTOM GAGE LINES (3.4.4.8 AND 3.4.4.9 ABOVE). TWO SHUT-OFF VALVES AND A BY-PASS VALVE SHALL BE PROVIDED.

3.8.2 THE TANK SHALL BE PROVIDED WITH A PRESSURE GAGE, CONNECTED TO THE TOP GAGE LINE (3.4.4.8 ABOVE).

3.8.3 THE TANK SHALL BE PROVIDED WITH A HASTINGS THERMOCOUPLE VACUUM GAGE SENSING TUBE, CONNECTED TO THE VACUUM SPACE THROUGH A SUITABLE VALVE AND PERLITE FILTER.

3.8.4 A BATTERY-POWERED PORTABLE THERMOCOUPLE VACUUM GAGE READ-OUT SHALL BE PROVIDED FOR THE TANK.

3.9 PRESSURE BUILDING SYSTEM

3.9.1 THE TANK SHALL BE PROVIDED WITH A PRESSURE BUILD-UP SYSTEM, COMPLETE WITH AMBIENT AIR HEATED VAPORIZING HEAT EXCHANGER.

3.9.2 THIS SYSTEM SHALL INCLUDE A LIQUID SUPPLY LINE WITH SHUT-OFF VALVE (MAY BE BRANCHED OFF BOTTOM FILL LINE); A VAPOR RETURN LINE (3.4.4.5) WITH SHUT-OFF

VALVE; A PNEUMATIC REGULATING VALVE; NECESSARY PIPING SAFETY VALVES (3.7.3); IF HEAT EXCHANGER IS SHIPPED LOOSE, FLANGES FOR FIELD CONNECTIONS TO AND FROM HEAT EXCHANGER.

3.9.3 THIS SYSTEM SHALL BE SIZED TO MAINTAIN TANK PRESSURE PER 2.8 WHILE LIQUID NITROGEN IS DELIVERED PER 2.6 SO LONG AS THE LIQUID NITROGEN DEPTH IS TWO FEET OR MORE.

3.9.4 THE LOCATION OF THE PRESSURE BUILDING SYSTEM RELATIVE TO THE STORAGE TANK WILL BE AGREED UPON AT THE TIME OF CONTRACT AWARD.

TESTING AND DOCUMENTATION

IN ADDITION TO TESTING REQUIRED BY THE ASME CODE

4.1 THE TANK SHALL BE HELIUM MASS-SPECTROMETER (1 E-8 STD CC/SEC) TESTED FOR VACUUM-TIGHTNESS OF INNER AND OUTER VESSELS.

4.2 PIPING SHALL BE TESTED AT 90% OF M.A.W.P. AND ALL JOINTS, INCLUDING SAFETY DEVICE INLET CONNECTIONS, SHALL BE SOAP BUBBLE CHECKED FOR LEAKAGE.

4.3 THE MANUFACTURER SHALL FURNISH TO THE BUYER THE CODE UI-A FORM AND CERTIFICATE(S) OF MASS SPRECTOMETER AND PIPING TESTS.

5.0 WARRANTY

5.1 VACUUM: VACUUM NOT TO EXCEED 200 MICRONS COLD 12 MONTHS AFTER START-UP OR 18 MONTHS AFTER SHIPMENT, WHICHEVER COMES FIRST.

5.2 GENERAL: MANUFACTURER TO WARRANT MATERIAL AND WORKMANSHIP FOR A PERIOD OF ONE YEAR FROM START-UP OR 18 MONTHS FROM SHIPMENT, WHICHEVER COMES FIRST.