



Fermilab

**Particle Physics Division
Mechanical Department Engineering Note**

Number: MD-ENG-293

Date: 10 December 2010

Project Internal Reference:

Project: NOvA FHEP Pivoter @ CDF Hydraulic Piping FESHM 5031.1 Engineering Note for Hydraulic Drive System.

Title: NOvA Pivoter Hydraulic Piping FESHM 5031.1 Engineering Note

Author(s): Dave Pushka

Reviewer(s):

Erik Voirin 10/15/26 N 

Key Words: Piping, FESHM 5031.1

Applicable Codes:

Abstract Summary:

Two of the three hydraulic systems on the FHEP Pivoter for NOvA at CDF includes Fermilab furnished and fabricated piping. The drive system uses $\frac{3}{4}$ nominal piping while the pivot cylinders use $2\frac{1}{2}$ and 2 inch piping. The third system, the kneeling jacks, only uses vendor supplied hydraulic hose.

This note specifically addresses the Pivoter Drive System provided by CMA/Flodyne/Hydradyne. It provides the calculations to show the chosen piping materials are suitable for the design pressure and meet the requirements of FESHM 5031.1

FESHM 5031.1 PIPING ENGINEERING NOTE FORM

Prepared by: Dave Pushka

Preparation Date: 12-10-2010

Piping System Title: NOVA Pivoter Hydraulics – Drive System

Lab Location: CDF

Lab Location code: B0

Purpose of system / System description: Hydraulic Piping

Piping System ID Number: not applicable

Appropriate governing piping code: ASME A17.1 Safety Code for Elevator and Escalators

Fluid Contents: Mobile DTE 24 Hydraulic Fluid

Design Pressure: 3000 psig

Design Temperature: 100 F

Piping Materials: Carbon Steel

Drawing Numbers (PID's, weldments, etc.): 3929.000-MD-486010

Designer/Manufacturer: Fermilab / See Vendor Contact Information below.

Test Pressure: 450 psig

Test Fluid: Oil

Test Date: 11-18-2010

Statements of Compliance

Piping system conforms to FESHM 5031.1, installation *is not* exceptional: Yes / No

Piping system conforms to FESHM 5031.1, installation *is* exceptional and has been designed, fabricated, inspected, and tested using sound engineering principles: Yes / No

Reviewed by: _____

Erik Voirin

(Print Name)

Signature: _____

[Handwritten Signature]

Date: _____

Mar 11, 2011

D/S Head's Signature: _____

Date: _____

The following signatures are required for exceptional piping systems:

ES&H Director's Signature: _____

Date: _____

Director's Signature or Designee: _____

Date: _____

Pipe Characteristics

Size: 3/4 inch ips.

Length: about 120 inches

Volume: less than 5 gallons

Relief Valve Information

Type: RPEC-LNN

Manufacturer: Sun

Set Pressure: 28 bar

Relief Capacity: 95 liters per minute

Relief Design Code: none identified. Relief Capacity exceeds hydraulic pump capacity.

Is the system designed to meet the identified governing code?

Yes / No

Fabrication Quality Verification: not applicable (A17.1 does not specify NDE of piping welds).

System Documentation

Process and Instrumentation diagram appended?

Yes / No

Process and Instrumentation component list appended?

Yes / No

Is an operating procedure necessary for safe operation?

Yes / No

If 'yes', procedure must be appended.

Exceptional Piping System

Is the piping system or any part of it in the above category?

Yes / No

If "Yes", follow the requirements for an extended engineering note for Exceptional Piping Systems.

Quality Assurance

List vendor(s) for assemblies welded/brazed off site: none

List welder(s) for assemblies welded/brazed in-house: Bill Gatfield

Append welder qualification records for in-house welded/brazed assemblies.

Append all quality verification records required by the identified code (e.g. examiner's certification, inspector's certification, test records, etc.) See following page:

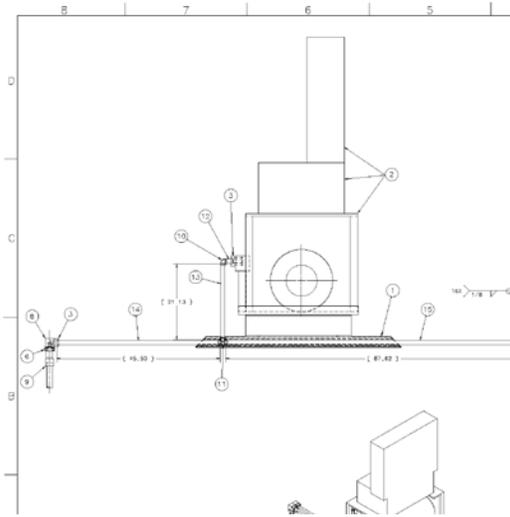
Discussion:

Table 1 in FESHM 5031.1 does not list a piping service or application that matches this system. This system is a hydraulic system, but not intended to lift and elevator or hoist. Rather, this system is a hydraulic drive system analogous to the hydrostatic drives used on earthmoving equipment.

Searching for hydraulic piping standards from ASME or SAE (Society of Automotive Engineers) yields no standards or specifications specific to piping. ASME B31 series codes do not fully apply to the piping used for hydraulic fluid system. For example, ASME B31 codes use ANSI B16.5 flanges, not code 61 and code 62 flanges used with hydraulic fluid power systems which conform to SAE J518 or ISO 6162.

So, the decision was to apply the ASME A17.1 Safety Code for Elevator and Escalators to this system.

Drawing showing the drive system hydraulic piping:



Welder Qualifications:



Fermi National Accelerator Laboratory

Technical Division - Machine Shop

WELDER PERFORMANCE QUALIFICATION TEST REPORT

Welder's Name: William Garfield #04609 ASME No. W-12
 Welding Process(es): ISI GTAW Manual Type _____ 2nd Type _____
 In accordance with WPS No. FERMILCS-1

Item: Fillet Reproduction Weld Test Coupon
 Groove Double Welded: Yes No
 Single Welded: Metal Fused Metal Non-Fused Non-Metal Open Root Consumable Insert
 With Solid Backing Without Solid Backing
 Base Metal: Spec. SA 106 m. SA 106 (ASME IX) P. No. 1 to P. No. 1
 Plate Pipe Tube
 Actual Thickness _____ Nominal Diameter 4.5" Actual Diameter 4.5" IDD _____
 Qualified Range _____ WPS No. 20 Qual. Thick Range 0.10674 Wall _____
 Acrop Thickness 0.007 Qual. Dia Range 2.758 min Qual. Thick Range _____
 Qual. Dia Range _____

1st Process Spec. SA 5.18 Class ER70S-2 2nd Process _____
 Dia(s) 3/32 Dia(s) _____
 P. No. 4 P. No. _____
 Deposit Thickness 0.007 Range Qual. 0.10674 Deposit Thickness _____ Range Qual. _____

Position(s) (JFA, etc.): 6G If Vertical Up Down _____
 Gas (Type and Composition): Fuel _____ Shielding Ar-99.9% Root Side Backing Ar 99.9%
 Electrical Type Current AC DC - Reverse DC - Straight
 Transfer GMAW Spray Globular Pulse Short Circuit

FOR INFORMATION ONLY	MACHINE WELDING
Filler Metal Trade Name: _____	Control: <input type="checkbox"/> Visual <input type="checkbox"/> Remote Visual
E.A.W. Filler Trade Name: _____	Arc Voltage Control: <input type="checkbox"/> Amm <input type="checkbox"/> Other _____
Shielding Gas Trade Name: _____	Joint Tracking: <input type="checkbox"/> Yes <input type="checkbox"/> No

VISUAL INSPECTION
 Appearance: Satisfactory Undercut _____ Piping porosity _____

GUIDED BEND TEST

TYPE AND FIGURE	RESULTS	TYPE AND FIGURE	RESULTS	TYPE AND FIGURE	RESULTS

Test Conducted by _____ Lab Test No. _____
 Date _____

RADIOGRAPHIC TEST
 Results Satisfactory Per ASME IX-2007 and ASME III.1-06
 Radiographer Allgood Inspection Co., Inc Examiner Jennifer Amos, Level II Test No. 176214 Date 4/20/2009

FILLET WELD TEST RESULTS
 Fracture Test: _____
 Location, Nature, and Size of Crack or Tear in Specimen _____
 Length of Weld _____ inch. Length of Defect _____ inch. _____ % of Defect
 Macro Test: Fusion _____
 Appearance: Fillet size: _____ inch x _____ inch Convex Concave
 Test Conducted by _____ Lab Test No. _____

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of ASME IX-2007 and ASW D1.1-06 Fermi National Accelerator Laboratory

By Gregg Allgood Date 5/1/2009

Calculations:

Pipe Material:	A106 Grade B Seamless
Maximum Operating temperature:	100 Fahrenheit
Diameters:	$\frac{3}{4}$
Schedule:	80
Maximum Allowable Stress per ASME B31.1-2004 Appendix A, Table A-1:	15,000 psi
Maximum Allowable Stress per ASME B31.3-2008 Appendix A, Table A-1:	20,000 psi
Outside Diameter, D:	As shown in table below
Wall thickness, t:	As shown in table below
Maximum Working Pressure, P:	As calculated in table below
Corrosion allowance, C:	0.0 (this piping is used indoors with non-corrosive oil on the inside and is not threaded nor has any wall thickness reductions).
Joint Efficiency, e	1.0 for seamless pipe
Percent Elongation for A106Gr B, E:	30
Min. Factor of Safety per ASME A17.1 Rule 1302.5a:	$F = (5.04/(30-2.8)) + 2.7 = 2.89$
Minimum Allowable F governs:	$F = 3.0$
Yield Point, Y.P. for A106Grade B:	35 ksi per ASME B31.1 Table A-1
Allowable Stress, S, as calculated by ASME A17.1 Rule 1302.5b:	$S = (Y.P./ F) = 35 \text{ ksi} / 3 = 11.67 \text{ ksi}$
Per ASME A17.1 Rule 1302.4:	$P = 2 * e * S * (t - C) / D$

Result is that the ASME A17.1 Safety Code for Elevator and Escalators is more stringent for the allowable stress for A106 grade B pipe than is ASME B31.1 or ASME B31.3.

Using the allowable stress values from ASME A17.1, calculate the allowable internal pressure for each size of schedule 80 pipe used where the outside diameter and wall thickness come from the ANSI pipe specification and the allowable internal pressure is calculated using the formula from ASME A17.1 Rule 1302.4 as written above.

Nominal Pipe Size	Pipe Outside diameter, (inches)	Wall thickness for Sch. 80, (inches)	Allowable Internal Pressure as calculated by rule 1302.4 in ASME a17.1, (psi)
3/4	1.049	0.154	3,426



1000 Muirfield Drive
Hanover Park, IL 60133
Phone: (630) 563-3600
Fax: (630) 563-3850

Thursday, 13 August 2009

Fermilab
Kirk & Wilson Roads
P.O. Box 500
Batavia, IL 60510

Attention: Mr. David Pushka, Engineering
Subject: Hydraulic Drive for Nova Block Raiser

Dear Dave,

CMA/Flodyne/Hydradyne is please to quote a complete hydraulic solution for you Nova Block Raiser drive control. Specifications for determining the solution are as follows:

- Total maximum mass, 600,000 pounds
- Maximum speed 1 MPH
- Acceleration rate to maximum speed 30 seconds
- Road resistance polyurethane on concrete
- 1 percent grade
- Two drive wheels, 36" diameter on common axle

The system provided will consist of the following components:

- Hydrostatic closed loop drive with the following assembled skid:
 - Reservoir with filler-breather, level and temperature gauge
 - Closed loop hydrostatic pump nominal pressure rating of 5800 PSI with pressure override, variable volume
 - 75 HP 1800 RPM 460/3/60 TEFC electric motor
 - Charge pump filter with electrical bypass indicator
 - Hot oil shuttle valve
 - Return filter with electrical bypass
 - Air/oil heat exchanger to maintain adequate cool sump oil temperature
- Electrical control panel assembled and mounted on skid consisting of the following:
 - Door mounted disconnect switch

MAIN DISTRIBUTION CENTERS

3265 Gateway Road, Suite 300
Brookfield, WI 53045
Phone: (262) 781-1815
Fax: (262) 781-2521

1000 Muirfield Drive
Hanover Park, IL 60133
Phone: (630) 563-3600
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Green Bay, WI Tel (920) 336-7620
Fax (920) 336-7610



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- Motor starter and overloads for 75 HP motor
- Motor starter and overloads for air/oil heat exchanger
- Pendant with disconnect for motor start/stop, emergency stop, joystick for forward/reverse motion of Nova Block Raiser
- All necessary transformers, power supplies, amplifiers and circuit breakers for complete machine control
- Two Bosch-Rexroth GFT0040 gear boxes with fixed displacement piston motors, wheel mount configuration to meet above specifications. Hydraulic motors will be mounted to gear boxes and shipped loose.
- Startup assistance provided by CMA/Flodyne/Hydradyne after unit is installed by Fermilab personnel

Net cost for above \$59,260.00

Terms: Net 30 after shipment

Delivery 12 - 16 weeks after approval of drawing

Drawings and engineering review will take approximately 2-5 days after receipt of order. This quotation does not include installation at Fermilab or the first fill of oil. Hydrostatic drive will be tested at CMA/Flodyne/Hydradyne for correct operation of control, pressure and flow. As noted above CMA/Flodyne/Hydradyne will provide startup assistance after unit has been installed and piped at your facility (Batavia, IL). Startup assistance and/or service work may be contracted for at facilities outside Illinois. Commercial terms for startup may be negotiated and service is provided per our attached service rates.

Thank you for thinking of CMA/Flodyne/Hydradyne for your hydraulic and control needs. If you need further information or assistance please don't hesitate to call.

Best regards,

Norman Kronowitz

cc: Mike Colaianne, CMA/Flodyne/Hydradyne MRO Salesman

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Line #	Line Type	PO Line Category	Description (Start with a Noun) (240 Characters Maximum, Enter Additional Description in Cell Below Line Item)	Quantity, Unit of Measure and Price		Project Information		Split Coding Qty's	
				Quantity	Unit of Measure	Price per Unit	Extended Price		Project
4			UN Number Hazard Class	Quantity			Project		
				Unit of Measure			Task		
				Price per Unit			Exp. Type		
				Extended Price			Exp. Org.		
5			UN Number Hazard Class	Quantity			Project		
				Unit of Measure			Task		
				Price per Unit			Exp. Type		
				Extended Price			Exp. Org.		
6			UN Number Hazard Class	Quantity			Project		
				Unit of Measure			Task		
				Price per Unit			Exp. Type		
				Extended Price			Exp. Org.		

ITEMS TO BE COMPLETED BY THE REQUESTER:

NOTE: Bolded items **must** be filled-in before requisition can be processed.

- | | |
|---|--|
| <ol style="list-style-type: none"> 1. APPROVALS 2. REQUEST ORIGINATOR 3. DESCRIPTION ON ENTIRE REQUISITION 4. NOTE TO APPROVER 5. JUSTIFICATION 6. REQUESTER 7. DELIVER TO LOCATION 8. NOTE TO BUYER 9. SUGGESTED VENDOR/SITE/CONTACT/TELEPHONE 10. REFERENCE # 11. NEED-BY-DATE <p>Attachments)</p> <ol style="list-style-type: none"> 12. PROJECT/TASK/EXP. TYPE AND EXP. ORG. 13. BUILDING MAINTENANCE 14. NOTE TO RECEIVER 15. TOTAL OF REQUISITION 16. LINE TYPE receipt) 17. PO LINE CATEGORY 18. DESCRIPTION OF LINE 19. QUANTITY 20. UNIT OF MEASURE 21. PRICE PER UNIT 22. EXTENDED PRICE 23. PROJECT/TASK/EXP. TYPE AND EXP. ORG. 24. SPLIT CODING QUANTITIES | <p>Area for your Division/Section, Business Office, NEPA and Directorate approvals</p> <p>Name, extension and mail station of person completing the requisition</p> <p>Short description (240 characters) identifying what is being purchased</p> <p>Short note (240 characters) to approver</p> <p>Short note (240 characters) to justify purchase of item</p> <p>Name of person expecting delivery of item</p> <p>Location where Fermilab's Receiving Dept. is to deliver the item once it comes in. Mail Station is not a valid location.</p> <p>Short note (240 characters) to buyer indicating previous P.O. number, and term of service if Line Type is SN, etc., must be placed in Attachments</p> <p>Your recommendation for selecting a vendor, including name, address, contact, telephone number</p> <p>Your internal means of identifying a requisition</p> <p>For Line Types, GR/GN the date is the desired day of delivery, for Line Type, SN the date is the day the service begins, (Note: for SN, place the term of the service in the "Description" of the line field or "Note to Buyer" in the</p> <p>Project/Task and Exp.Type where entire requisition is charged and Exp. Org. - organization spending the money</p> <p>Circle Yes or No, if yes is circled FIMS number is required</p> <p>Short note (240 characters) to Fermilab's Receiving Dept.</p> <p>Total amount of all items listed on requisition</p> <p>Valid type used to determine whether item is for goods or services; example: GR (goods receipt), SN (service non-receipt)</p> <p>Valid category for item being requested; example - clothing, furniture, medical, computers/pc's, etc.</p> <p>A description for each item and term of service if Line Type is SN (240 character)</p> <p>The number of units requested per item</p> <p>Unit of measure for each item requested</p> <p>The dollar amount you have authorized the Procurement Department to spend for an item</p> <p>Extended price for each item requested</p> <p>Project/Task and Exp.Type where line items are charged and Exp. Org. - organization spending the money, if different from above</p> <p>Quantities applied to each Project/Task/Expenditure Type and Expenditure Organization</p> |
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