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TEST SET UP AND RESULTS STUDY OF HIGH TEMPERATURE BALL VALVE

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Abstract : **This study aims to investigate material stability and leakage rates of ball valves at elevated temperature. This valve is a ball valve that is primarily used for pipeline on-off and flow control applications, primarily for offshore use on FPSOs. There is a significant focus on safety in the present market, and this project was established with the use of ball valves in steam, gas, and hot oil applications in mind. Using a specialized test setup and helium gas as the media, we are investigating and testing the valve's external leakages under severe, extreme heat conditions. We have verified the valve design in this project. Using an experimental setup, the ball valve is examined**

I. INTRODUCTION

By opening, closing, or partially obstructing different passages, a valve regulates, directs, or controls the flow of a fluid (gases, liquids, fluidized solids, or slurries). Although technically a type of fitting, valves are typically considered separately. Fluid moves from higher pressure to lower pressure through an open valve. The word comes from the Latin valve, which is the component of a door that moves. From valve, it is also possible to spin or roll.

II. LITERATURE REVIEW: -

Mahesh Kamkar1 and Professor S.R. Basavaraddi: A valve is a mechanical device that controls a fluid's flow or pressure. High pressure ball valves are one of the various types of valves that are used in industries like industrial hydraulics and marine hydraulics. The goal of the current study is to construct a high pressure valve with a nominal diameter of 25mm (DN 25 and PN 350). The valves are referred to as high pressure valves when the flow line surpasses 150bar. The design of various valve components becomes crucial as the pressure rises. The design of high pressure ball valve components is influenced by a number of variables, including temperature ratings and pressure. For the sealing cup, ball, connection adaptor, valve housing, and operating lever, design calculations are made.

Professors AKSHAY CHOUGUL1 and RAMESH KATTI: When building facilities to transfer oil and gas products, ball valves are a common industrial fitting (piping systems). They are straight through flow valves that are quarter-turned (90 degrees), with a round closure element and complementary rounded seats that provide for uniform sealing stress. The valve pressure rating and construction materials can affect the type of seat. design the ball valve's flange and shell for a 35 bar pressure. With the aid of the computer programme CATIA V5, the design of the Ball Valve Shell & Flange is modelled using CAD. ANSYS 14.5 is used for static analysis of the Ball Valve Shell body and Flange design to determine the highest safe stress for an equivalent payload/pressure.

Study the primary contributions of many writers as the flow forces operating on the spool rise primarily with rising volumetric flow rate, according to N. Kumar in paragraph six. If a quick valve opening is desired, the drive system should be able to overcome these forces. With an increase in pump flow rate, the flow force's peak value rises, but its location doesn't change. The valve function ports are only one factor to consider when selecting a valve for a particular application. Experimental testing on a setup test stand has confirmed the proposed solution.

III. Methodology

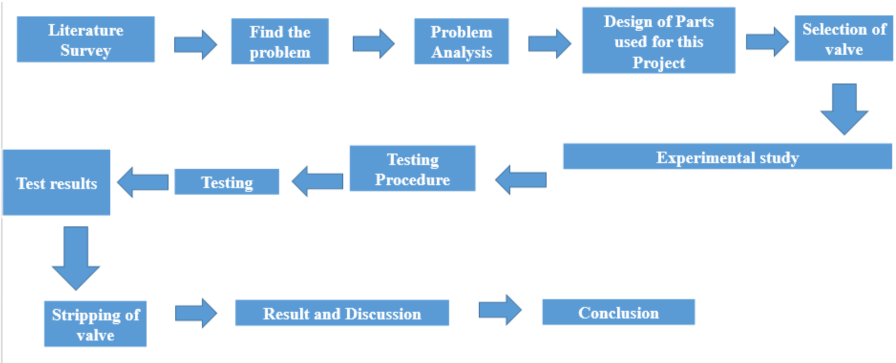

Fig. 1 Methodology

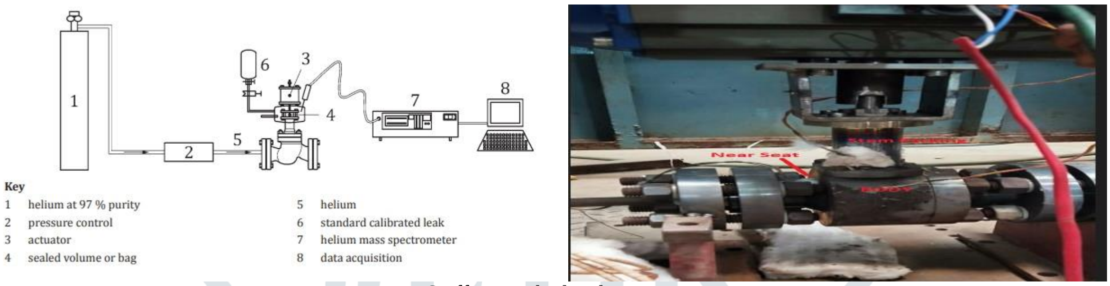

Fig. 2 Sniffing Method and test set up

Leaks from valves are found using a portable equipment (mass flow spectrometer). Although the type of instrument detector is not defined, the tightness class restrictions must be met by the chosen detector and its sensitivity. This method is only used to identify and categorise leaks; it is not a direct indicator of the bulk emission rates from specific sources.

Testing Procedure

This procedure addresses testing requirements as per various standards; namely:
API 6D : 25th Edition:2021,API 598: 10th Edition:2016.ISO 5208: 2015
Valves selected-1" 900 Floating ball valve
Material of construction-Body-A 182 F22, Ball-Seat- F6a+stellite 6, Stem-Inconel 718

Hydrostatic Shell Test: The valve shell's ability to contain pressure, along with that of the packing chamber and stem retention, is confirmed by the shell test (i.e. Anti-Blowout stem design).Plug the Body Vent/Drain connection after removing the External relief valve (if installed). Over the test rig, mount the test valve. Both sides of the test valve should be closed. Keep the test valve partially open. Open the test rig's inlet valve and let the test fluid completely fill the test valve. Set the test valve's pressure to the Shell test value of 238 kg/cm2. Close the test rig's inlet valve once the test pressure has been reached and stabilised. Keep a close eye on the pressure gauge for at least a short while to look for any pressure drops. Examine the shell and each joint..

Hydrostatic Seat Test: The seat leakage test verifies the valve seats' capacity to seal in the flow directions for which they were intended. Utilizing test flanges or locators, clamp the test valve to the test rig. Fill the valve and its cavity entirely with test fluid when the valve is only partially open. The ball should be rotated into the closed position. depending on the valve's class, apply the hydrostatic seat pressure of 174Kg/cm2 for the allotted test time. Watch for leaks coming from the body vent or the other side of the valve, and look for any pressure drops. reverse the flow through the valve and repeat the process (for bi-directional valves).

Pneumatic Seat Test: Utilizing test flanges or locators, clamp the test valve to the test rig. Before beginning the low-pressure gas seat test on the valve, drain the hydrostatic test fluid from it. Apply pneumatic pressure (6.2 kg/cm2) for the time period required for the test. Watch for leaks coming from the body vent or the opposite valve side. Flip the valve over on the opposite side and repeat the process described above (for bi-directional valves).
Operational Torque Test: The maximum operational differential pressure under conditions of room temperature is where the torque necessary to open a valve must be measured.
High Temperature Test:(538 Degree C)Test Fluid: Helium Gas (97% minimum purity)
A minimum of 20 operations must be performed at high and ambient temperatures for each thermal cycle, and seat leakages must be documented. Range of temperatures: 29 to 38 Bar of test pressure temperatures 538 Dynamic Test Pressure of 55.3 Bar (Open/Close Cycling) Pressure Test of Gas at Max. Rated Temperature At least 20 cycles must be completed in each of the high-temperature tests.
Gas Body Test at Maximum Rated Temperature Ideally, the valves would be open. According to ASME B16.34:2020, the test pressure must equal the maximum rating pressure at the test temperature. The exam will last for five minutes. If the pressure change seen on the pressure measuring instrument is less than 5% of the test pressure or 500 psi (3.45 MPa), whichever is smaller, a gas body test at maximum temperature will be acceptable..
Gas Seat Test at Maximum Rated Temperature According to ASME B16.34:2020, the maximum rating pressure at test temperature must be applied on the upstream side of the valves and released on the downstream side. The exam will last for five minutes. After the test has been completed, the pressure must be removed.

Low Pressure Seat Test at Maximum Rated Temperature The Valves must be exposed to a differential pressure of at least 80 psi and no more than 10% of the rated working pressure (5.5 bar). The pressure must be delivered to the valves' upstream side and released from their downstream side. The exam will last for five minutes..

Readings-

R+A3:H54EPORT NO.:	28936-01-HT-DN25-CL900-FBV-01	**REFERENCE PROCEDURE:**	PJVM-TS-079 Rev. 0
TEST DATE:	03-12-2022	**REFERENCE GAD:**	2231337-01 REV 00
S.O. NO REF.:	SO-337		

VALVE SERIAL NO	WO NO	PRODUCT DESCRIPTION	SIZE	PRESSURE RATING	QTY (NOS)	STEM DIA (mm)
28937-01	MRP22/28937	TRUNNION MOUNTED BALL VALVE	DN 25	#900	1	Ø26.4
			Full BORE			
		GEAR OPERATED	RINJ TYPE JOINT			

VALVE/S MATERIAL OF CONSTRUCTION

COMPONENT	BODY & ADAPTER	BALL	STEM	FASTNERS	SEAT	SEAL
MATERIAL	ASTM A182 GR. F22	ASTM A182 Gr.F6A + STELLITE	API6A INCONEL 718	ASTM A193 GR. B16 ASTM A194 GR. 7	ASTM A182 Gr.F6A + STELLITE	GRAPHITE

HYRDO PRESSURE TESTING AT AMBIENT TEMPERATURE (28 ^{o}C)

TEST FLUID:	WATER WITH 15.2 PPM CHLORIDE CONENT		TEST TEMPERAURE:	AMEBIENT (28 ^{o}C)			
TYPE OF TEST	SPECIFIED TEST PRESSURE (Kg/cm^2)	ACTUAL TEST PRESSURE (Kg/cm^2)	TEST DURATION (Seconds)	TEST RESULT	INSTRUMENTS/ GAUGES USED		
					ID	Range	DUE DATE
Hydro Shell:	238	240	120	No Leakage Observed- Satisfactory	PJVM/PG-420/14	0-420 kg/cm2	13-01-2023
Hydro Seat Body Side:	174	175	120	0 drops/minute observed- Satisfactory	PJVM/PG-420/14	0-420 kg/cm2	13-01-2023
Hydro Seat B/A Side:	174	175	120	0 drops/minute observed- Satisfactory	PJVM/PG-420/18	0-420 kg/cm2	13-01-2023
Pneumatic Seat Body Side:	6.2	6.5	120	No Leakage Observed- Satisfactory	PJVM/PG-16/25	0-16 kg/cm2	05-01-2023
Pneumatic Seat B/A Side:	6.2	6.5	120	No Leakage Observed- Satisfactory	PJVM/PG-16/25	0-16 kg/cm2	05-01-2023

ALLOWABLE SEAT LEAKAGE RATE AS PER ISO5208 RATE D: Hydro seat test: 2.4 drops/minute; Gas seat test: 687 bubbles/minute and or 0.05 litre/minute

TORQUE TESTING AT PRESSURE: 105.43 Kg/cm^2 (Actual test pressure: 110 Kg/cm^2)

TEST FLUID:	WATER WITH 15.2 PPM CHLORIDE CONENT		TEST TEMPERAURE: AMEBIENT (28 ^{o}C)			
TYPE OF TORQUE	REQUIRED TORQUE (Nm)	OBSERVED TORQUE** (Nm)	TEST RESULTS	INSTRUMENTS/ GAUGES USED		
				ID	RANGE	DUE DATE
BREAK TO OPEN(BTO) Body Side:		140	Observed Torque is within acceptable Limits	PJVM/TW/0-200/01	0-200 Nm	19-04-2023
RUN TORQUE Body Side:		80	Observed Torque is within acceptable Limits			
END TO CLOSE (ETC) Body Side:		100	Observed Torque is within acceptable Limits			
BREAK TO OPEN(BTO) B/A Side:		136	Observed Torque is within acceptable Limits			
RUN TORQUE B/A Side:		80	Observed Torque is within acceptable Limits			
END TO CLOSE (ETC) B/A Side:		100	Observed Torque is within acceptable Limits			

** Torque testing carried out with Gear Box (Model: QT-150 Sr No.: A-500, MA: 14)

GAS PRESSURE TESTING AT ROOM TEMPERATURE (28 ^{o}C) AT 0 MECHANICAL CYCLES

TEST FLUID:	HELIUM GAS (97% MINIMUM PURITY)		TEST TEMPERAURE:	ROOM TEMPERAURE (28 ^{o}C)	MECHNICAL CYCLES:		0
TYPE OF TEST	SPECIFIED TEST PRESSURE (Kg/cm^2)	ACTUAL TEST PRESSURE (Kg/cm^2)	TEST DURATION (Seconds)	TEST RESULT	INSTRUMENTS/ GAUGES USED		
					ID	RANGE	DUE DATE
Gas Shell:	155.1	156	120	No Leakage Observed- Satisfactory	PJVM/PG-420/14	0-420 kg/cm2	13-01-2023
Gas Seat Body Side:	155.1	156	120	0 bubbles/minute observed - Satisfactory	PJVM/PG-420/14	0-420 kg/cm2	13-01-2023
Gas Seat B/A Side:	155.1	156	120	0 bubbles/minute observed - Satisfactory	PJVM/PG-420/18	0-420 kg/cm2	13-01-2023
Low Pressure Gas Seat Body Side:	6.2	6.5	120	No Leakage Observed- Satisfactory	PJVM/PG-16/25	0-16 kg/cm2	05-01-2023
Low Pressure Gas Seat B/A Side:	6.2	6.5	120	No Leakage Observed- Satisfactory	PJVM/PG-16/25	0-16 kg/cm2	05-01-2023
STEM LEAKAGE:	155.1	156	120	6.1 x 10^{-6} mbar.l.s			

ALLOWABLE SEAT LEAKAGE RATE AS PER ISO5208 RATE D: Hydro seat test: 2.4 drops/minute; Gas seat test: 687 bubbles/minute and or 0.05 litre/minute

ALLOWABLE STEM LEAKAGE RATE AS PER ISO 15848-1: 4.46 X 10^{-5} mbar.l.s

GAS PRESSURE TESTING AT ROOM TEMPERATURE (28 ^{o}C) AFTER 20 MECHANICAL CYCLES

TEST FLUID:	HELIUM GAS (97% MINIMUM PURITY)		TEST TEMPERAURE:	ROOM TEMPERAURE (28 ^{o}C)	MECHNICAL CYCLES:		20
TYPE OF TEST	SPECIFIED TEST PRESSURE (Kg/cm^2)	ACTUAL TEST PRESSURE (Kg/cm^2)	TEST DURATION (Seconds)	TEST RESULT	INSTRUMENTS/ GAUGES USED		
					ID	RANGE	DUE DATE
Gas Seat Body Side:	155.1	156	120	0 bubbles/minute observed - Satisfactory	PJVM/PG-420/14	0-420 kg/cm2	13-01-2023
Gas Seat B/A Side:	155.1	156	120	0 bubbles/minute observed - Satisfactory	PJVM/PG-420/14	0-420 kg/cm2	13-01-2023
Low Pressure Gas Seat Body Side:	6.2	6.5	120	No Leakage Observed- Satisfactory	PJVM/PG-420/18	0-420 kg/cm2	13-01-2023
Low Pressure Gas Seat B/A Side:	6.2	6.5	120	No Leakage Observed- Satisfactory	PJVM/PG-16/25	0-16 kg/cm2	05-01-2023
STEM LEAKAGE:	155.1	156	120	5.6 x 10^{-6} mbar.l.s			

ALLOWABLE SEAT LEAKAGE RATE AS PER ISO5208 RATE D: Hydro seat test: 2.4 drops/minute; Gas seat test: 687 bubbles/minute and or 0.05 litre/minute

ALLOWABLE STEM LEAKAGE RATE AS PER ISO 15848-1: 4.46 X 10^{-5} mbar.l.s

GAS PRESSURE TESTING AT HIGH TEMPERATURE (538 OC) AT 0 MECHANICAL CYCLES							
TEST FLUID:	HELIUM GAS (97% MINIMUM PURITY)		TEST TEMPERAURE:	HIGH TEMPERAURE (538 C)	MECHNICAL CYCLES:		0
TYPE OF TEST	SPECIFIED TEST PRESSURE (Kg/cm^2)	ACTUAL TEST PRESSURE (Kg/cm^2)	TEST DURATION (Seconds)	TEST RESULT	INSTRUMENTS/ GAUGES USED		
					ID	RANGE	DUE DATE
Gas Shell:	155.1	156	120	No Leakage Observed- Satisfactory	PJVM/PG-420/14	0-420 kg/cm2	13-01-2023
Gas Seat Body Side:	155.1	156	120	100 bubbles/minute observed - Satisfactory	PJVM/PG-420/14	0-420 kg/cm2	13-01-2023
Gas Seat B/A Side:	155.1	156	120	80 bubbles/minute observed - Satisfactory	PJVM/PG-420/18	0-420 kg/cm2	13-01-2023
Low Pressure Gas Seat Body Side:	6.2	6.5	120	30 bubbles/minute observed - Satisfactory	PJVM/PG-16/25	0-16 kg/cm2	05-01-2023
Low Pressure Gas Seat B/A Side:	6.2	6.5	120	20 bubbles/minute observed - Satisfactory	PJVM/PG-16/25	0-16 kg/cm2	05-01-2023
STEM LEAKAGE:	155.1	156	120	4.5×10^{-6} mbar.l.s			
ALLOWABLE SEAT LEAKAGE RATE AS PER ISO5208 RATE D: Hydro seat test: 2.4 drops/minute; Gas seat test: 687 bubbles/minute and or 0.05 litre/minute							
ALLOWABLE STEM LEAKAGE RATE AS PER ISO 15848-1: 4.46×10^{-5} mbar.l.s							
GAS PRESSURE TESTING AT HIGH TEMPERATURE (538 OC) AFTER 20 MECHANICAL CYCLES							
TEST FLUID:	HELIUM GAS (97% MINIMUM PURITY)		TEST TEMPERAURE:	HIGH TEMPERAURE (538 C)	MECHNICAL CYCLES:		20
TYPE OF TEST	SPECIFIED TEST PRESSURE (Kg/cm^2)	ACTUAL TEST PRESSURE (Kg/cm^2)	TEST DURATION (Seconds)	TEST RESULT	INSTRUMENTS/ GAUGES USED		
					ID	RANGE	DUE DATE
Gas Shell:	155.1	156	120	No Leakage Observed- Satisfactory	PJVM/PG-420/14	0-420 kg/cm2	13-01-2023
Gas Seat Body Side:	155.1	156	120	200 bubbles/minute observed - Satisfactory	PJVM/PG-420/14	0-420 kg/cm2	13-01-2023
Gas Seat B/A Side:	155.1	156	120	150 bubbles/minute observed - Satisfactory	PJVM/PG-420/14	0-420 kg/cm2	13-01-2023
Low Pressure Gas Seat Body Side:	6.2	6.5	120	80 bubbles/minute observed - Satisfactory	PJVM/PG-16/25	0-16 kg/cm2	05-01-2023
Low Pressure Gas Seat B/A Side:	6.2	6.5	120	60 bubbles/minute observed - Satisfactory	PJVM/PG-16/25	0-16 kg/cm2	05-01-2023
STEM LEAKAGE:	155.1	156	120	7.5×10^{-6} mbar.l.s			
ALLOWABLE SEAT LEAKAGE RATE AS PER ISO5208 RATE D: Hydro seat test: 2.4 drops/minute; Gas seat test: 687 bubbles/minute and or 0.05 litre/minute							
ALLOWABLE STEM LEAKAGE RATE AS PER ISO 15848-1: 4.46×10^{-5} mbar.l.s							
GAS PRESSURE TESTING AT ROOM TEMPERATURE (28 ^{O}C) AT 0 MECHANICAL CYCLES (AFTER COOLING)							
TEST FLUID:	HELIUM GAS (97% MINIMUM PURITY)		TEST TEMPERAURE:	ROOM TEMPERAURE (28 ^{O}C)	MECHNICAL CYCLES:		0
TYPE OF TEST	SPECIFIED TEST PRESSURE (Kg/cm^2)	ACTUAL TEST PRESSURE (Kg/cm^2)	TEST DURATION (Seconds)	TEST RESULT	INSTRUMENTS/ GAUGES USED		
					ID	RANGE	DUE DATE
Gas Shell:	155.1	156	120	No Leakage Observed- Satisfactory	PJVM/PG-420/14	0-420 kg/cm2	13-01-2023
Gas Seat Body Side:	155.1	156	120	50 bubbles/minute observed - Satisfactory	PJVM/PG-420/14	0-420 kg/cm2	13-01-2023
Gas Seat B/A Side:	155.1	156	120	60 bubbles/minute observed - Satisfactory	PJVM/PG-420/14	0-420 kg/cm2	13-01-2023
Low Pressure Gas Seat Body Side:	6.2	6.5	120	20 bubbles/minute observed - Satisfactory	PJVM/PG-16/25	0-16 kg/cm2	05-01-2023
Low Pressure Gas Seat B/A Side:	6.2	6.5	120	30 bubbles/minute observed - Satisfactory	PJVM/PG-16/25	0-16 kg/cm2	05-01-2023
STEM LEAKAGE:	155.1	156	120	5.5×10^{-6} mbar.l.s			
ALLOWABLE SEAT LEAKAGE RATE AS PER ISO5208 RATE D: Hydro seat test: 2.4 drops/minute; Gas seat test: 687 bubbles/minute and or 0.05 litre/minute							
ALLOWABLE STEM LEAKAGE RATE AS PER ISO 15848-1: 4.46×10^{-5} mbar.l.s							
Conclusion- Valve performance is found satisfactory as ISO 5208 rate D and ISO 15848-Part -1							

IV. Conclusions

I. The test set up is successfully working to test the high temperature valves at elevated temperatures, This study shows these valves are working fine at elevated temperatures, here are no permanent deformations observed in the valves, this proves that material selection up the mark and design and calculation and method of calculations is also fine, Complete method for verification of testing and working of valves at higher temperature is established The test set up is successfully working to test the high temperature valves at elevated temperatures, This study shows these valves are working fine at elevated temperatures, here are no permanent deformations observed in the valves, this proves that material selection up the mark and design and calculation and method of calculations is also fine, Complete method for verification of testing and working of valves at higher temperature is established

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References

[1] Mahesh Kamkar1, Prof.S.R.Basavaraddi:- CONCEPTUAL DESIGN AND ANALYSIS OF HIGH PRESSURE BALL VALVE, International Research Journal of Engineering and Technology (IRJET) Volume: 02 Issue: 03 | June-2015

[2] AKSHAY CHOUGUL1, Prof. RAMESH KATTI2 Study of Ball Valve and Design of Thickness of Shell and Flange, International Research Journal of Engineering and Technology (IRJET) Volume: 04 Issue: 10 | Oct -2017

[3] Ramesh Harrylal, Michael A Porter, “Analysis and optimization of a butterfly valve disc”; Proceedings of the Institution of Mechanical Engineers; Part E: Journal of Process Mechanical Engineering, 223: 81, 2019.

[4] Ahmad Ibrahim Qassim; “Fluid and structural analysis of a large diameter butterfly valve” Journal of Advanced Manufacturing Systems, Vol. 8, No. 1, 81–88, 2018

[5] Sreekala s. k, Thirumalini Subramaniam: A.T. Bhosale, A.S. Dhekane; “Finite Element Analysis of Butterfly Valve Disc”; International Journal of Engineering Research & Technology (IJERT) Vol. 2 Issue7, July – 2017

[6] N. Kumar:"; "Optimization of 16" Plug Valve Body Using FEA and Experimental Stress Analysis Method"; International Journal of Mechanical Engineering ISSN: 2277-7059 Volume 1 Issue 1.2021

[7] D.V. Bitner Engineering Optimization"; third Edition by A Wiley Interscience publication.

{8] Prof. Sanjeev. A. Janawade 1, Mr. Venukumar R Bankapur; Design and Analysis of High Pressure Ball Valve Sealing Cup with Different Sealing Materials, International Research Journal of Engineering and Technology (IRJET),volume: 02 Issue: 04 | July-2015

[9] Philip L. Skousen "Valve Handbook";; Second Edition, Tata McGraw-Hill.

[10] Ref International Standards- API 6D, ASME B 16.34, ISO15841-pa