PROJECT INTERNSHIP REPORT ON

" TWIN STATION NRV TESTING RIG "

at

Brakes India Limited

Submitted by

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In partial fulfillment for the award of the degree of

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An AUTONOMOUS Institution
Affiliated to ANNA UNIVERSITY, Chennai

RAJALAKSHMI ENGINEERING COLLEGE
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BONAFIDE CERTIFICATE

Certified that this Report titled "TWIN STATION NRV TESTING RIG" is the bonafide work of ASWINI KUMAR (2116201201060), KHALID SHAJAHAN (2116201201057) and ROHINDH P (2116201201043) who carried out the work under my supervision. Certified further that to the best of my knowledge the work reported herein does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

MR. G.M. KUMARAVEL
Senior General Manager
Technology Development Department
Brakes India Pvt ltd

ACKNOWLEDGEMENT

I would like to extend my sincere gratitude and appreciation to Brakes India for providing the platform and resources necessary for the completion of this project report.

Special thanks are due to Senior General Manager **G.K. Kumaravel** for his exemplary leadership, unwavering support, and invaluable guidance throughout the duration of this project. His depth of knowledge and insightful feedback have been instrumental in shaping the direction and outcome of this report.

I am also immensely grateful to Project Manager **Mathavan** for his dedication, expertise, and unwavering commitment to excellence. His meticulous attention to detail and strategic oversight have been crucial in navigating the complexities of this project and ensuring its successful completion.

Furthermore, I extend my heartfelt thanks to **HR Ramprasath** for his assistance and support in facilitating the necessary administrative processes and resources required for the smooth execution of this project.

Additionally, I would like to acknowledge Project In charge **V.S.Vinay Kumar** for his leadership and coordination efforts, which have played a vital role in ensuring effective communication and collaboration among team members throughout this endeavor.

I would also like to express my gratitude to the entire team at Brakes India for their collaboration, cooperation, and support throughout this endeavor. Your collective efforts have been essential in overcoming challenges and achieving our objectives.

1.COMPANY DESCRIPTION - BRAKES INDIA PVT LTD

Established in 1962, Brakes India stands as a prominent supplier of braking systems in the Indian market and a global provider of ferrous castings, catering to passenger vehicles, light commercial vehicles, heavy commercial vehicles, and tractors. Affiliated with the TSF Group, tracing its roots back to 1936, the company boasts robust in-house research and development capabilities, including cutting-edge test facilities and an international standard high-speed test track. Recognized for world-class manufacturing, Brakes India has earned a reputation for delivering top-quality products through an extensive supply chain, serving renowned original equipment manufacturers worldwide. The renowned iron foundry, operating in India and Oman, produces over 200,000 tons of safety-critical castings. Trusted brands such as TVS-Girling, TVS-Apache, and TVS-Sprinter dominate the spare parts segment. With revenues exceeding INR 6,500 crores, Brakes India has earned accolades like National Awards for Energy Conservation, Leadership and Excellence Award in Safety, Health & Environment, TPM Excellence Award, and the prestigious Deming Application Prize.

2.INTERNSHIP DETAILS

Throughout our enriching internship at Brakes India Pvt Ltd, we were privileged to be part of the Technology Development Department, guided by the astute leadership of Mr. G.M. Kumaravel, General Senior Manager of the Technology Development department. Our initial interaction with him provided invaluable insights into the trajectory of our project-centric journey at Brakes India. Engaging in discussions with Mr. Kumaravel not only offered clarity on our objectives but also emphasized the company's unwavering commitment to cultivating a culture of continuous learning and innovation within the realm of automotive technology. This experience laid a strong foundation for our exploration into the cutting-edge developments within the automotive industry.

2a. Introduction to Braking Systems

Our initiation into the realm of braking systems at Brakes India Pvt Ltd marked the commencement of a riveting journey into the heart of automotive engineering. The comprehensive introduction session unveiled the intricate dance of components, materials, and precision engineering that defines modern braking technology. Led by seasoned engineers with a wealth of experience, the session not only provided theoretical insights but also offered a glimpse into the practical challenges and innovations that drive the industry forward. The discourse on safety standards, performance optimization, and the symbiotic relationship between innovation and reliability underscored the critical role braking systems play in shaping the automotive landscape. With each revelation, the connection between theoretical knowledge and real-world applications became apparent, setting the stage for a hands-on exploration that would define our internship experience. This introductory phase laid the foundation for an immersive and enlightening journey into the intricate world of braking technology.

2b. Guidance from Professionals

At Brakes India Pvt Ltd, learning about braking systems wasn't just an introduction to machines but a deep dive into a culture where experienced professionals guided and mentored us. The mentorship provided by industry experts elevated our understanding of automotive precision and engineering. The professionals at Brakes India, with their extensive experience, became invaluable mentors, generously sharing insights garnered over years of navigating the dynamic automotive landscape. Engaging in one-on-one discussions and collaborative problem-solving sessions, their guidance went beyond the conventional classroom teachings, offering a practical understanding of the challenges and innovations inherent in the field. Learning from professionals who had weathered industry shifts and technological advancements instilled a sense of resilience and adaptability. Regular interactions with professionals, including engineers and project managers, facilitated an open exchange of ideas and insights. Their willingness to share real-world experiences and address queries fostered a collaborative learning environment.

2c. Hands-On Experience

A significant aspect of our internship involved hands-on experience with the diverse range of machines used in the manufacturing facility. The pinnacle of our internship experience unfolded through hands-on engagement with the development of the "Twin Station NRV Testing Rig." This phase marked a transition from theoretical understanding to the practical application of engineering principles, providing an opportunity to contribute actively to a cutting-edge project. The fabrication and assembly of the testing rig became the nucleus of our hands-on experience. Working alongside skilled technicians and engineers, I delved into the intricacies of design, material selection, and assembly processes. The initial stages involved interpreting engineering drawings and transforming them into tangible components. Operating machinery and utilizing fabrication tools became second nature as we meticulously crafted the components that would constitute the Twin Station

NRV Testing Rig. Assembling the rig brought theoretical concepts to life. Attaching sensors, configuring the automation system, and integrating the various components showcased the practical application of theoretical knowledge. The project team's collective efforts, under the guidance of experienced engineers, transformed the individual components into a sophisticated testing apparatus. Programming the automation system was a pivotal aspect of our hands-on experience. Collaborating with automation experts, I learned to translate the testing parameters into a language the rig could understand. Testing and calibrating the rig offered a dynamic learning curve. Adjusting parameters, troubleshooting, and fine-tuning the system for optimal performance underscored the iterative nature of engineering projects. In essence, this phase not only solidified our technical skills but also cultivated a deep sense of pride in contributing to the forefront of automotive engineering innovation.

3.PROJECT DESCRIPTION
TITLE - TWIN STATION NRV LEAK TEST RIG

3a. Abstract

The project focuses on designing and implementing the "Twin-Station Non-Return Valve (NRV) Leak Test Rig," a critical apparatus for evaluating the operational characteristics of diaphragm-based Non-Return Valves in automotive brake boosters. With three sequential tests, the rig assesses key factors crucial for the proper functioning of brake booster assemblies.

In the initial test, the valve seating of the NRV undergoes scrutiny, applying 0.2 bar pressure to the intake manifold end. Leakage is examined against a 0.025 bar threshold, ensuring compliance with stringent quality standards. This foundational test verifies the NRV's ability to maintain secure valve seating.

The second test meticulously examines weld integrity, applying 1.5 bar pressure to the intake manifold end. The system checks whether leakage remains below 0.025 bar, ensuring the welded components exhibit robust integrity. This step is critical for overall reliability and safety in brake booster assemblies.

The third test involves a vacuum simulation, subjecting the intake manifold end to 50 mm Hg of vacuum. Within a specified timeframe, it ensures vacuum pressure drops below 20 mm Hg. This real-world simulation assesses the NRV's effectiveness under rapidly reduced pressure conditions, a vital parameter for brake systems.

Failure in any of these tests results in the unequivocal classification of the NRV as faulty, leading to its subsequent discard. This stringent quality control mechanism ensures that only NRVs meeting predefined criteria for leak tolerance, weld integrity, and vacuum pressure are integrated into brake booster assemblies. The "Twin-Station NRV Leak Test Rig" project signifies a meticulous and critical endeavor to advance quality and performance standards in the automotive industry, ensuring the safety and reliability of braking systems.

Fig 1 - NRV used in Braking Systems

3b. Problem Scope

The current manual testing procedures for Non-Return Valves (NRVs) in automotive braking systems pose a significant challenge in terms of time efficiency and potential operational drawbacks. The conventional manual testing approach demands a considerable amount of time, often leading to prolonged testing cycles and delayed production timelines.Moreover, the manual testing of NRVs is susceptible to human error, making it inherently less reliable. The variations in testing parameters, subjective judgment, and potential oversight during manual testing may compromise the precision required for ensuring the safety and reliability of braking systems. This unreliability introduces an element of risk, as it becomes challenging to consistently achieve the stringent quality standards demanded by the automotive industry. In light of these challenges, the need for an automated solution is evident. The implementation of an automated testing system for

NRVs addresses the inefficiencies associated with manual testing, significantly reducing testing times and enhancing the accuracy and consistency of results.

3c. Resolution Approach

In response to the time-related challenges and operational drawbacks associated with manual Non-Return Valve (NRV) testing at Brakes India Pvt Ltd, a robust solution is proposed through the development of the "Twin Station NRV Testing Rig." This advanced testing rig integrates cutting-edge technologies, including Programmable Logic Controllers (PLC), pneumatic systems, and Manual Human-Machine Interface (HMI) Calibration, to streamline the testing process, enhance precision, and mitigate the risk of defective NRVs entering the production line.

1. **PLC Integration:**

The heart of the proposed solution lies in the incorporation of Programmable Logic Controllers (PLC). The PLC system is programmed to execute testing protocols with unparalleled accuracy, ensuring consistent and repeatable results. This automation allows for the optimization of various testing parameters, such as pressure levels, leak detection thresholds, and test duration. Real-time monitoring capabilities of the PLC system further enhance the efficiency of data collection, providing instantaneous feedback on the NRV's performance during the testing cycle. The integration of PLC technology not only reduces testing times but also elevates the reliability of NRV testing in the automotive manufacturing workflow.

2. **Pneumatic Systems:**

The introduction of pneumatic actuators adds a dynamic element to the testing rig, enhancing both speed and reliability. Pneumatics provide a swift and precise means of controlling pressure, contributing significantly to the reduction of testing times. By utilizing pneumatic systems, the testing rig

achieves robust and efficient manipulation of NRVs under test conditions, simulating real-world scenarios with a high degree of accuracy. The consistent and repeatable application of pressure ensures minimal variations, addressing one of the key challenges associated with manual testing methods.

3. **Manual HMI Calibration:**

To enhance adaptability and flexibility in the testing process, the solution includes a Manual Human-Machine Interface (HMI) Calibration feature. This interface allows operators to fine-tune testing parameters manually, facilitating adjustments based on specific testing requirements or evolving industry standards. The Manual HMI Calibration feature ensures that operators maintain control over the testing process while benefiting from the precision and speed afforded by automation. This adaptability proves crucial in accommodating changing industry dynamics and customizing testing procedures as needed.

4. **Defect Management:**

In addition to the automation and precision brought about by PLC, pneumatic systems, and Manual HMI Calibration, a fail bin system is introduced to manage defective NRVs effectively. The testing rig is designed to automatically segregate and redirect defective parts to a designated fail bin upon the detection of any anomalies during the testing process. This fail bin serves as a repository for NRVs that do not meet the specified quality standards. To further streamline the production line, the fail bin system includes an automatic ejection mechanism. When a defective NRV is identified during any of the three sequential tests conducted by the rig, the system triggers an automatic ejection, expelling the faulty component from the testing line and preventing it from advancing to subsequent production stages.

5. Benefits and Impact:

This comprehensive solution not only addresses the time-related challenges associated with manual NRV testing but also introduces a versatile and precise testing rig capable of meeting the stringent quality standards demanded by the automotive industry. By seamlessly integrating PLC, pneumatic systems, and Manual HMI Calibration, and incorporating defect management measures, the proposed solution represents a significant leap towards efficiency, reliability, and adaptability in NRV testing, ultimately contributing to enhanced safety and performance in automotive braking systems.

Fig 2 - The Twin Station NRV Testing Rig24

4.DESIGN DOCUMENTATION

4a.Pneumatic Layout

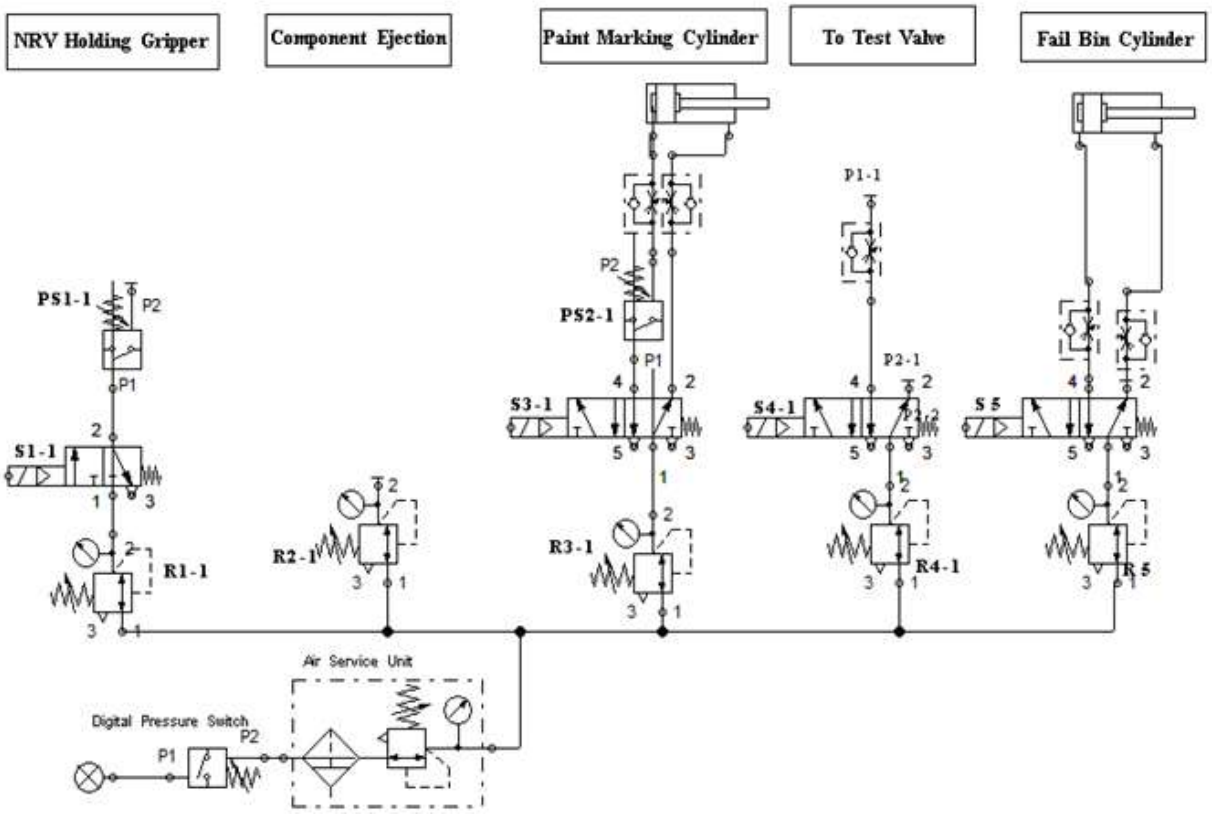

Fig 3: Actuation Circuit Station 1

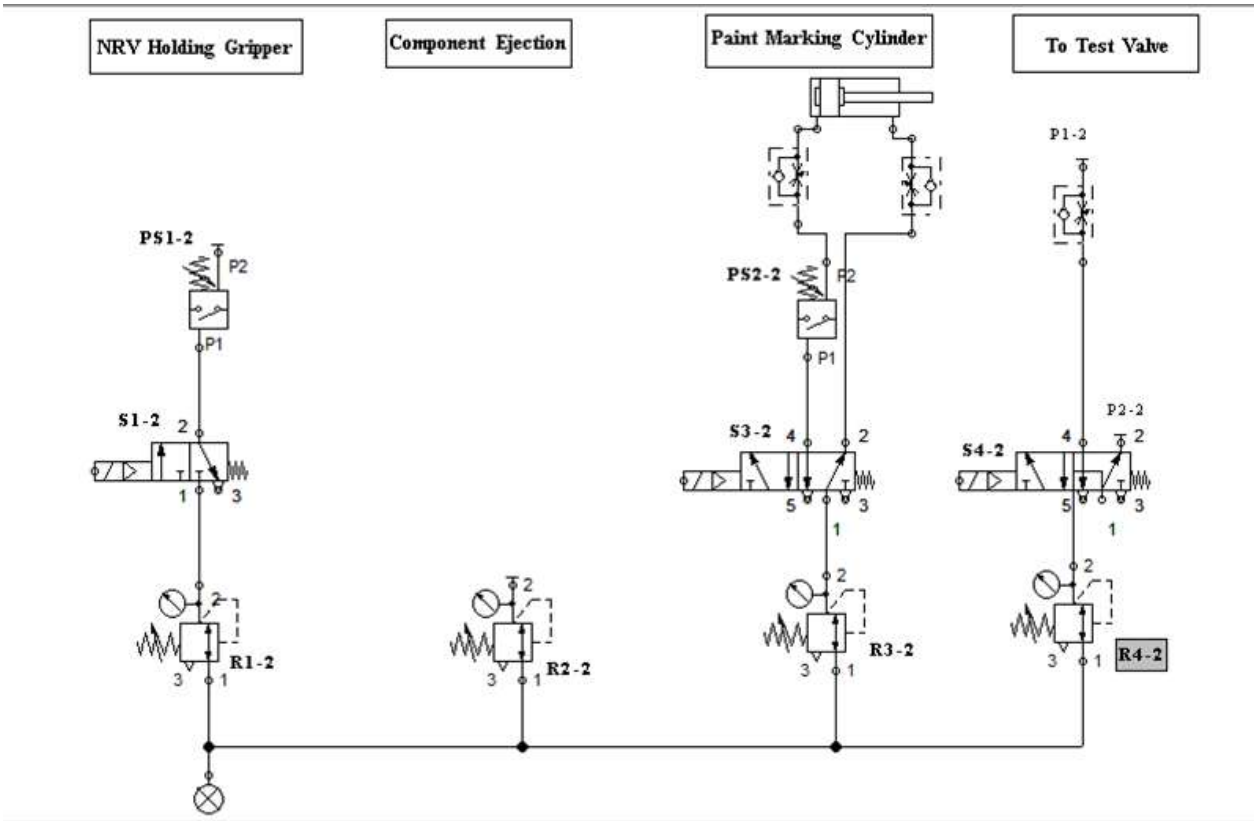

Fig 4: Actuation Circuit Station 2

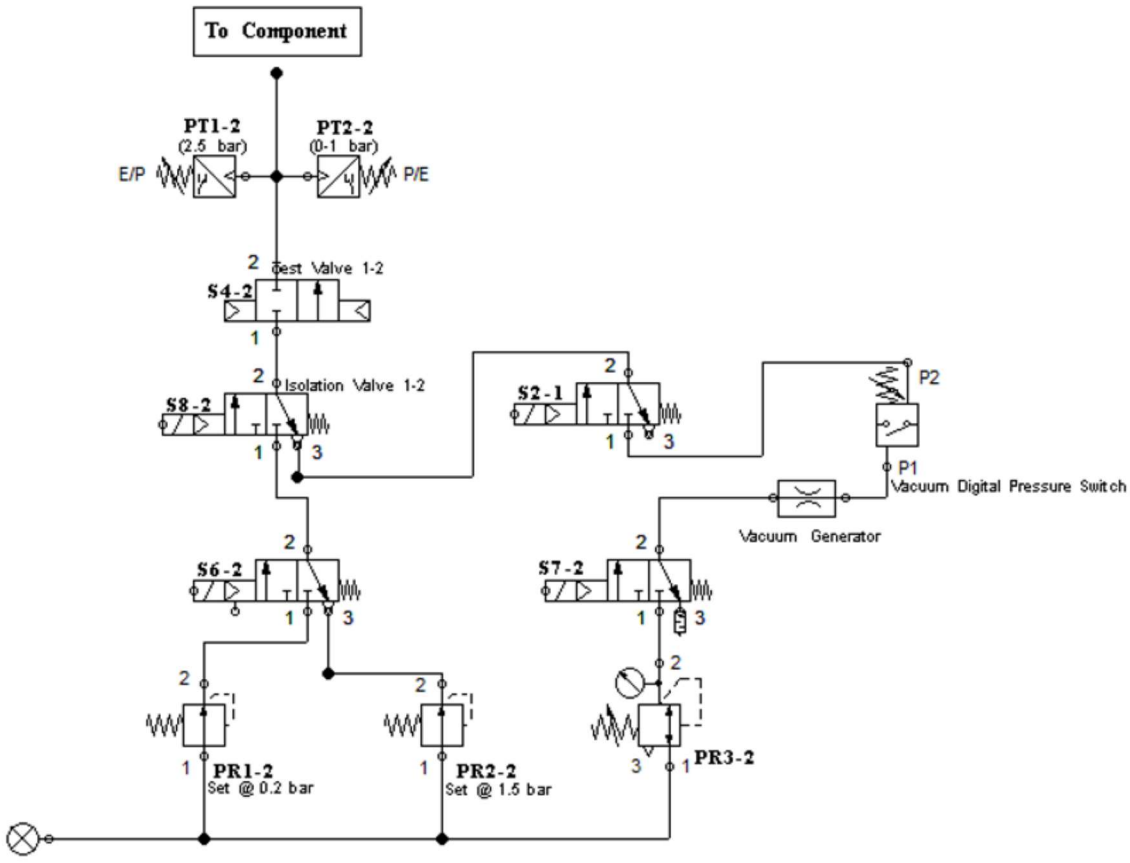

Fig 5: Test Circuit

4b. Electrical panel layout

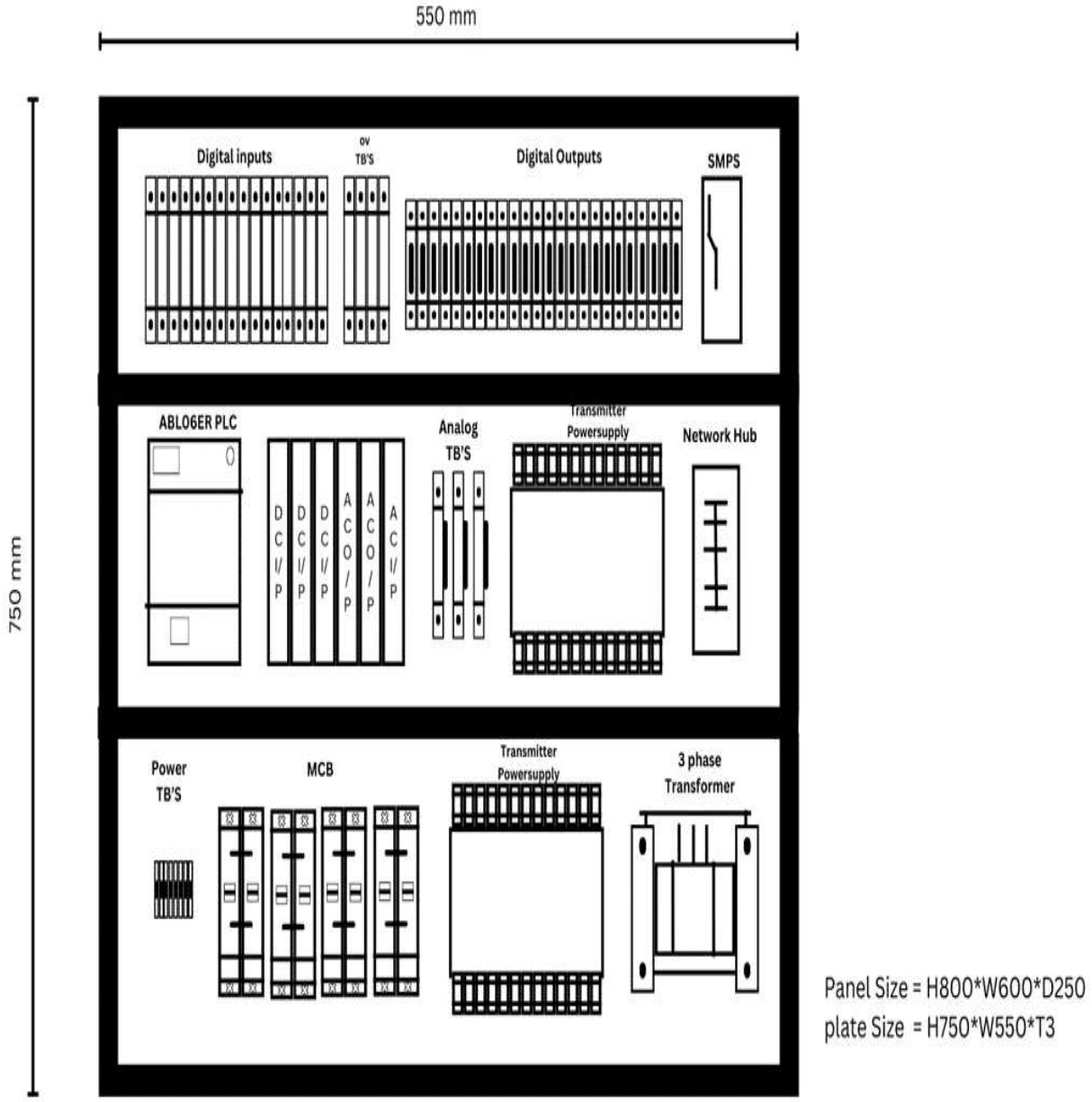

Fig 6: Electrical Panel

4c. Aluminum Layout

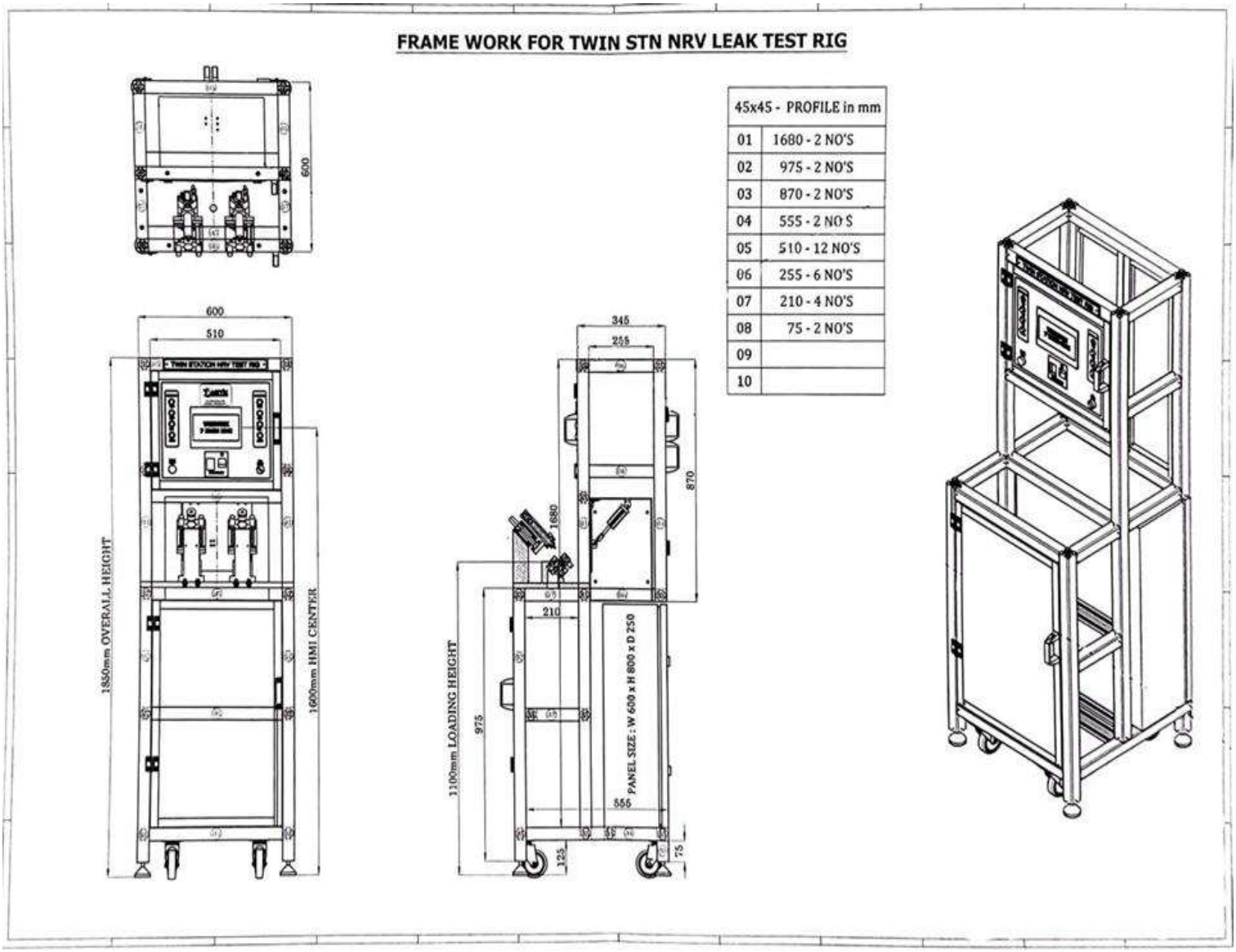

Fig 7:Aluminum Layout

4d.Fixture

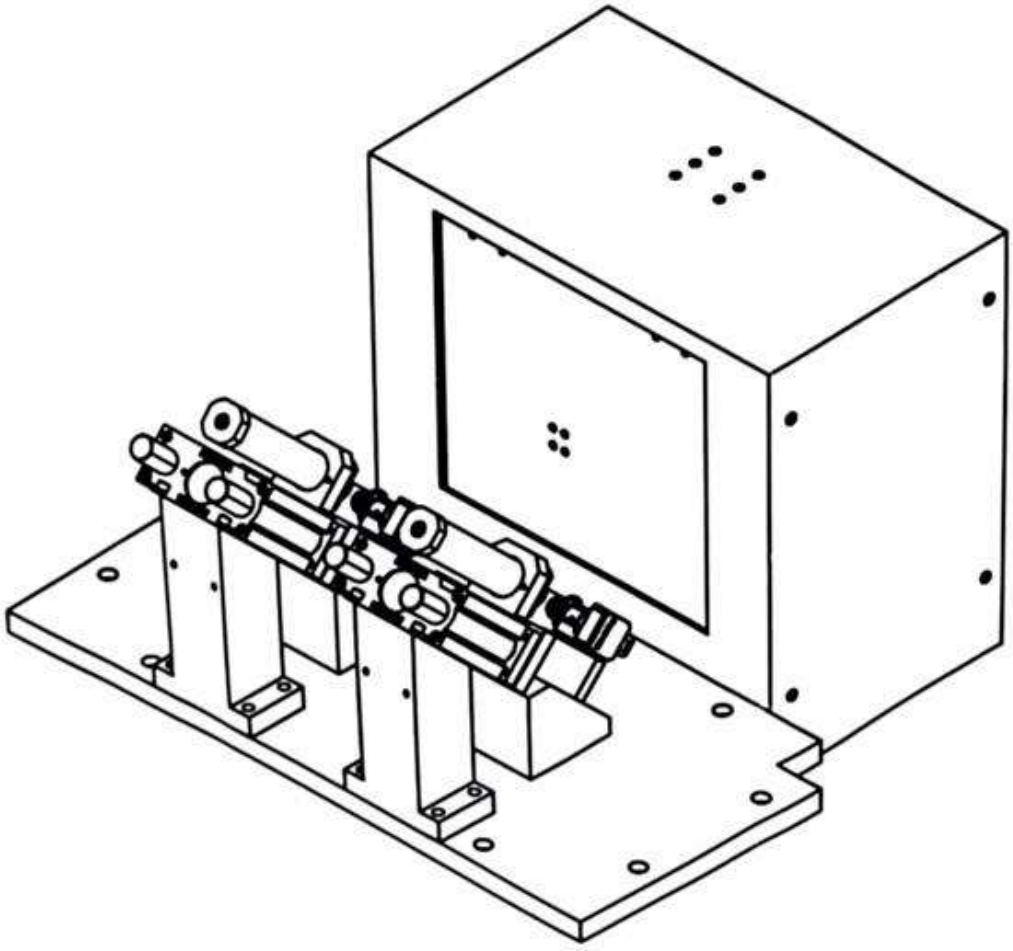

Fig 8: Fixture Layout

5.Cost sheet

Twin Station NRV Leak Test Rig -SPD			
Description	Qty	Unit Price	Amount
AB L306	1	₹15000	₹15000
Weintek 7" HMI	1	₹12000	₹12000
AB Analog module -5069 -IF8	1	₹10000	₹10000
AB OB 16 output moduie	1	₹10000	₹10000
AB Ig16 input module	1	₹10000	₹10000
Wika transmitter 0 to 2.5 bar ‘t	2	₹10000	₹20000
Wika transmitter 1 bar ABS	2	₹11000	₹22000
Electrical panel	1	₹10000	₹10000
Transformer	1	₹6000	₹6000
Ethernet switch	1	₹8000	₹8000
Tower lamp	1	₹3500	₹3500
Anjana power supply	2	₹3500	₹7000
Fail bin Contrinex proximity with cable	1	₹1500	₹1500
Electrical acc.		₹30000	₹30000
Electical and Electronic System			₹165000
SMC FRL Unit	1	₹9500	₹9500
SMC 5/2 Single solenoid valve	5	₹4000	₹20000
SMC 3/2 solenoid valve	6	₹3800	₹22800
SMC regulator	7	₹1500	₹10500
SMC precision regulator	6	₹6500	₹39000
CKD pressure switch	5	₹2000	₹10000
DPS Vacuum	2	₹3200	₹6400
SS Reservoir 1,5 L/2L	2	₹3500	₹7000
Dps Air	5	₹2800	₹14000
Festo vacuum Generator VN 30	2	₹8000	₹16000
Flow control valve	10	₹1000	₹10000
BI Test valve	4	₹15000	₹60000
SMC fitting, Quick exh. and tubing	1	₹15000	₹15000
Hardware accessories	1	₹10000	₹10000
Fluid control system			₹2,50,200
Main Fixture with base palte	1	₹75000	₹75000
Clamping cylinder	2	₹6000	₹12000
Stamping cylinder	2	₹3250	₹6500
Pass bin cylinder	1	₹2500	₹2500
Fail bin cylinder	1	₹2500	₹2500
Standard items (sbc shaft)	1	₹15000	₹15000
Fixture and Machine elements			₹1,13,500
Aluminium Profile with acd,	1	₹60000	₹60000
Carry wheel with plate	1	₹10000	₹10000
MS'sheet & Name plates	1	₹20000	₹20000
Profiles and Name plates			₹90000

Total Material Cost			₹618700
Equipment Design Charges	1	₹61870	₹61870
PLC Programming Charges	1	₹92805	₹92805
Project Planning and Execution Charges	1		₹123740
Overhead Charges		₹123740	₹278415
Packing and Forwarding	1	₹10000	₹10000
Freight	1	₹15000	₹15000
Insurance	1	₹5000	₹5000
Documentation and Manual	1	₹3510	₹3510
Freight and Insurance Charges			
Installation & Commissioning	1	₹9300	₹9300
Training of your Engineers	1	₹10075	₹10075
Installation and Training charges			₹19375
		Total	**₹9,50,000**

6.INTERNSHIP EXPERIENCE

Embarking on our internship journey at Brakes India Pvt Ltd proved to be a transformative experience, providing a comprehensive and hands-on understanding of professional project execution. The focal point of our internship was the meticulous development of the "Twin Station NRV Testing Rig," a multifaceted project split into five integral parts – Aluminum Profile Assembly, Fixture Layout, Electrical Layout, Pneumatic Layout, and PLC Programming. Each segment unfolded as a unique learning opportunity, allowing me to delve into diverse facets of engineering and project management.

The first leg of the project, Aluminum Profile Assembly, exposed me to the intricacies of working with 45x45mm aluminum profiles. Crafting the structural foundation of the testing rig demanded precision and attention to detail. This hands-on experience not only enhanced our mechanical skills but also provided insights into material selection, structural integrity, and the practical considerations essential for creating a robust and reliable framework.

Moving on to Fixture Layout, I delved into the meticulous arrangement of components within the rig. This phase underscored the significance of efficient space utilization and ergonomic design, essential for facilitating seamless operations and minimizing potential bottlenecks during the testing process. Designing fixtures that ensured optimal NRV positioning showcased the practical application of engineering principles in real-world scenarios.

The Electrical Layout segment illuminated the intricacies of electrical systems within the testing rig. Collaborating with electrical engineers, I gained valuable insights into circuit design, wiring, and the integration of sensors and actuators. This phase not only broadened our understanding of electrical systems but also emphasized the critical role they play in ensuring the reliability and functionality of automated testing apparatus.

Pneumatic Layout and Components introduced me to the world of pneumatic systems. Learning about the application of compressed air for precision control in manipulating NRVs during testing was enlightening. This segment provided insights into the design considerations, component selection, and safety measures associated with pneumatic systems, crucial elements in the overall functionality of the testing rig.

Fig 9 - Engaging with the equipment during its Testing Phase

The final component, PLC Programming, marked the culmination of our internship experience. Learning to program the Programmable Logic Controller (PLC) for the testing rig was a challenging yet immensely rewarding endeavor. The automation of testing protocols, real-time monitoring, and seamless integration of various components showcased the transformative power of programming in enhancing efficiency and precision in industrial processes.

Throughout this internship, the amalgamation of these diverse project components offered a holistic understanding of engineering and project management in a professional setting. Beyond technical skills, I cultivated effective communication, collaboration, and problem-solving abilities through interactions with cross-functional teams. The hands-on experience not only bridged the gap between theoretical knowledge and practical application but also instilled a sense of adaptability and resilience crucial for success in dynamic engineering environments.

In conclusion, our internship experience at Brakes India Pvt Ltd was a journey of exploration, growth, and practical learning. From the intricacies of working with aluminum profiles to mastering PLC programming, each facet of the "Twin Station NRV Testing Rig" project contributed to our professional development. This internship has equipped me with a diverse skill set, fostering a deep appreciation for the complexities and rewards embedded in real-world engineering projects. The invaluable lessons learned during this internship will undoubtedly shape our future endeavors in the field of engineering.