

Maintenance Strategy and its Importance in Rocket Launching System-An Indian Prospective

N Gayathri¹, Amit Suhane², Vivek Kumar Khare³

M. Tech Research Scholar, Dept. of Mechanical Engineering, M.A.N.I.T, Bhopal, M.P. India

Assistant Professor, Dept. of Mechanical Engineering, M.A.N.I.T, Bhopal, M.P. India

Scientist/Engineer-SE, Department of Space, (SLP)/VALF, Satish Dhawan Centre, SHAR, Sriharikota, ISRO, India

ABSTRACT: The present paper mainly describes the maintenance strategies followed at rocket launching system in India. A Launch pad is an above-ground platform from which a rocket or space vehicle is vertically launched. The potential for advanced rocket launch vehicles to meet the challenging , operational, and performance demands of space transportation in the early 21st century is examined. Space transportation requirements from recent studies underscoring the need for growth in capacity of an increasing diversity of space activities and the need for significant reductions in operational are reviewed. Maintenance strategies concepts based on moderate levels of evolutionary advanced technology are described. The vehicles provide a broad range of attractive concept alternatives with the potential to meet demanding operational and maintenance goals and the flexibility to satisfy a variety of vehicle architecture, mission, vehicle concept, and technology options.

KEYWORDS: Preventive Maintenance, Rocket Launch Pad.

I. INTRODUCTION

A. ROCKET LAUNCH PAD

A Launch pad is associate degree above-ground platform from that a rocket ballistic capsule is vertically launched. A launch advanced may be a facility which incorporates, and provides needed support for, one or a lot of launch pads. A launch pad usually contains a hard and fast or mobile service structure that provides one or a lot of access platforms to examine and maintain the vehicle, associate degree and point structure that provides the vehicle with propellants, refrigerant fluids, power, communications, and measure before launch. The service structure conjointly provides access to the crew cabin for vehicles carrying humans. The pad could contain a flame deflection structure to stop the extreme heat of the rocket exhaust from damaging the vehicle or pad structures, and a sound suppression system spraying giant quantities of water is also utilized. The pad may additionally be protected by lightning arrestors. A launch pad is distinct from a missile launch facility (or missile), that conjointly launches a missile vertically however is found underground so as to assist harden it against enemy attack, or conceal it from police work. refrigerant propellants (liquid atomic number 8 oxidiser, and liquid atomic number 1 fuel) got to be unendingly flat-topped off (i.e., boil - off replaced) throughout the launch sequence (countdown), because the vehicle awaits rising. This becomes notably necessary as an advanced sequence is also interrupted by planned or unplanned holds to repair issues. Most rockets want stable support for a number of seconds when ignition whereas the engines build up to stable, full thrust. Thus the vehicle is usually hung on the pad by hold - down arms or explosive bolts, that area unit triggered once the vehicle is stable and prepared to fly, at that purpose all point connections with the pad area unit discharged. [11]

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 7, July 2016

II. CLASSIFICATION OF LAUNCH PADS IN INDIA

A. SLV LAUNCH PAD

This launch pad was used by the Satellite Launch Vehicle and increased Satellite Launch Vehicle is found at the southern tip of this launch web site. It's been decommissioned. At first it had been designed for launching SLV-3s however was later additionally used as Associate in Nursing ASLV launch complicated.

B. FIRST LAUNCH PAD (FLP)

The modern First Launch Pad was inbuilt the early Nineties for the Polar Satellite Launch Vehicle. it's additionally been utilized by the geosynchronous Satellite Launch Vehicle. the 20th launch from the pad - a PSLV-XL with IRNSS-1A - occurred on one Gregorian calendar month 2013. the primary Launch Pad of the Satish Dhawan space Centre may be a rocket launch web site in Sriharikota, Asian country that began operation in 1993. It's presently utilized by two launch vehicles of the ISRO. The Polar Satellite Launch Vehicle (PSLV) and therefore the Geosynchronous Satellite Launch Vehicle (GSLV). It's one among two operational orbital launch pads at the positioning, the opposite being the Second Launch Pad, that opened in 2005. The primary launch from this pad occurred on 20 Sep 1993, and was the maiden flight of the Polar Satellite Launch Vehicle carrying the IRS-1E satellite.



Figure 1: First Launch Pad

SECOND LAUNCH PAD (SLP)

The SLP at SHAR is a state-of-the-art launch complex. SLP is configured as a universal launch pad capable of accommodating all the launch vehicles of ISRO including the advanced launch vehicles to be built in the next decade and beyond. It became operational in 2005.

The Second Launch Pad of the Satish Dhawan Space Centre is a rocket launch site in Sriharikota, India. It is the second of two launch pads at the centre. The Second Launch Pad or SLP was designed, supplied, erected & commissioned by MECON Limited, a Government of Indian Enterprise, located at Ranchi (Jharkhand, India) during the period March 1999 to December 2003. It cost about Rs 400 Cr at that time. The second launch pad with associated facilities was built in 2005. However it became operational only on 5 May 2005 with the launching of PSLV C6. The other Launch Pad being the First Launch Pad. It is used by Polar Satellite Launch Vehicles and Geosynchronous Satellite Launch Vehicles.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 7, July 2016



Figure 2: Second Launch Pad

C. THIRD LAUNCH PAD:

The Third Launch Pad (TLP) of the Satish Dhawan space Centre is associate underneath development rocket launch site in Sriharikota, India. Once the launch pads are going to be fully designed, it'll be the third launch pad within The Satish Dhawan space Centre, the other two being first Launch Pad and also the Second Launch Pad. This launch pad is meant to be used for future Indian rockets just like the geosynchronous Satellite Launch Vehicle Mk III and Avatar RLV (Avatar Reusable Launch Vehicle) likewise because the older ones like Polar Satellite Launch Vehicle and geosynchronous Satellite Launch Vehicle. This can be the launch pad which is able to be used for the Indian human space travel programme likewise as for India's manned mission to the Moon. One among the most reasons of building this launch pad is that it'll increase the frequency of orbital launches by ISRO.

III. AVAILABLE FACILITIES IN INDIA

The Centre has two operational orbital launch pads. SHAR is ISRO's satellite launching base and in addition provides launch facilities for the total vary of Rohini sounding rockets. The Vehicle Assembly, Static check and analysis advanced (VAST, antecedently STEX) and also the Solid Propellant space Booster Plant (SPROB) are placed at SHAR for casting and testing solid motors. The location additionally features a telemetry tracking & control centre, Liquid Propellant Storage and service Facilities (LSSF), the Management Service cluster and Sriharikota Common Facilities. The PSLV launch complex was commissioned in 1990. It has a 3,000 tonne, 76.5 m high Mobile Service Tower (MST) that provides the SP-3 payload clean room. The solid propellant house booster plant (SPROB) processes massive size propellant grains for the satellite launch vehicles. The Static check & analysis complex (STEX) tests and qualifies differing kinds of solid motor for launch vehicles. The control centre at SHAR homes computers and processing, closed circuit tv, period of time tracking systems and meteorologic observation instrumentation. it's connected to eight radars placed at Sriharikota and therefore the 5 stations of ISRO's measurement, following & Command Network (ISTRAC). The propellant production plant produces composite solid propellant for rocket motors of ISRO mistreatment ammonium perchlorate (oxidiser), fine aluminium powder (fuel) and hydroxyl group terminated polybutadiene (binder). The solid motors processed here embody those for the first-stage booster motor of the Polar Satellite Launch Vehicle (PSLV) a five segmented motor of 2.8 m diameter and 22 m length, weighing 160 tons with a thrust level of 450 tons. Rocket motors and their subsystems got to be strictly tested and evaluated on ground before they're declared flight worthy. The facilities at SDSC SHAR area unit used for testing solid rocket motors, each at close conditions and simulated high altitude conditions. Besides these, there are unit facilities for conducting Vibration, Shock, Constant Acceleration and Thermal/humidity tests. SDSC SHAR has infrastructure for launching satellites into low earth orbit,

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 7, July 2016

polar orbit and geo-stationary transfer orbit. The launch complexes offer support for vehicle assembly, fuelling, checkout and launch operations. The Centre additionally has facilities for launching sounding rockets for part studies. The mobile service tower, launch pad, preparation facilities for various launch stages & spacecraft, storage, transfer and union facilities for liquid propellants, etc., area unit the principal components of the PSLV/GSLV launch complex. For supporting the GSLV Mk III programme extra facilities area unit being originated at SDSC. a brand new plant (SPP) is about up to method heavier category boosters with two hundred tonnes of Solid propellant. The static check advanced is being increased for qualifying the S-200 booster. Alternative new facilities embody a Solid Stage Assembly Building, Satellite Preparation and Filling Facility and Hardware Storage buildings. The present liquid propellant and refrigerant propellant storage and filling systems, propellant service Facilities will be increased. [11]

IV. MERITS FOR ROCKET LAUNCHING SYSTEM

- Satellite Communication
- Disaster Management
- Navigation
- Climate & Environment[12]

V. MAINTENANCE AND ITS TYPES

Maintenance is a set of organized activities that are carried out in order to keep an item or equipment in its best operation condition with minimum cost acquired. [8]

Maintenance history as follows:

1. First Generation- Maintenance activities during this era thus got to be known as “breakdown maintenance” and arose only when the equipment or processes were not functioning or were shut down because they were producing unacceptable output or were unsafe to operate. It was until 1950.
2. Second Generation- in this generation began a new concept, that concept was simply following the recommendation of equipment manufacturers about the care that should be taken into the operation and maintenance of machines. This new trend also called preventive maintenance.
3. Third Generation- The time and needs change in 1960. Now require more efficient work output. In 1960 established new concept Productive Maintenance. More responsibilities are assigned to people related to maintenance and more concern about to reliability and design of equipment and plant.[9]

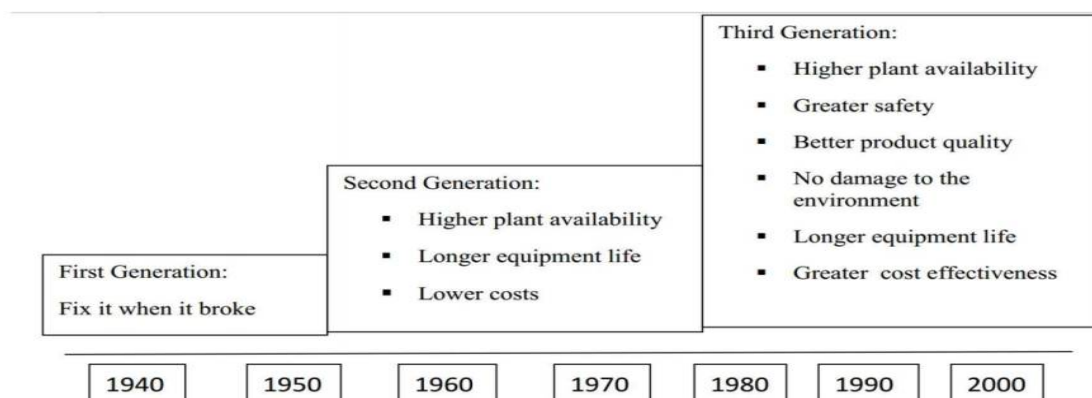


Figure 3: Maintenance History Chart [8]

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 7, July 2016

There are two types of maintenance

1. Planned Maintenance
2. Unplanned Maintenance

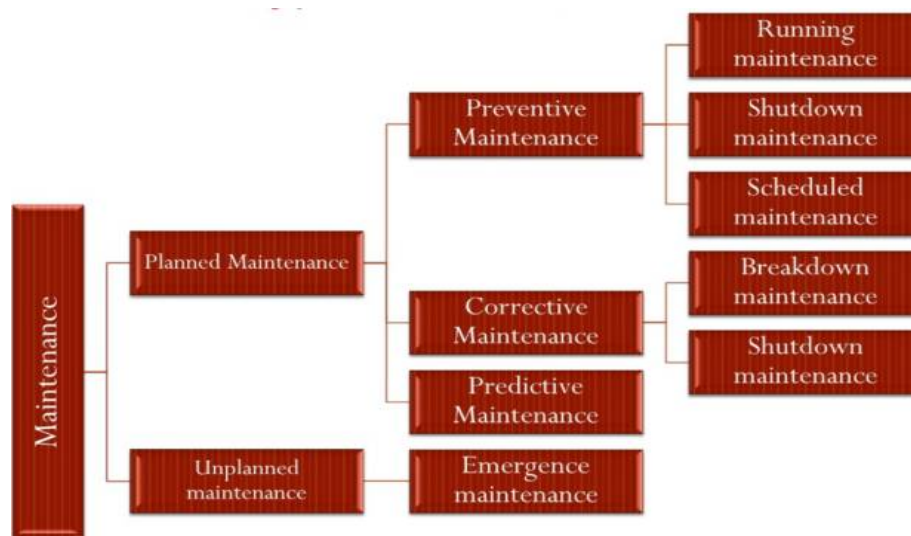


Figure 4: Maintenance Strategies Flow Chart [9]

VI. LITERATURE REVIEW

The challenges of responsive space and mitigating the risk of schedule slippage require a thorough understanding of the various factors driving the development schedule of a space system. The technology maturity of spacecraft subsystems and payload instruments (as measured by the TRL) has been identified as a major driver of schedule for space programs. However, various parameters, other than TRL, affect the variability of schedule slippage across multiple space programs and should therefore be investigated along with the technology maturity. The technology maturity of each instrument and the resulting Technology Readiness Level (TRL) heterogeneity, and their effects on the delivery schedule of a spacecraft are investigated[2]. as the pace of technological development continues to accelerate, new ways to infuse advanced designs will be needed. DoD, partly reflecting this awareness, has begun to embed technology maturity measurement in the acquisition process. The indices used to access the readiness of new designs therefore, take on added importance. The most widely used method in the aerospace community to assess readiness is the NASA-developed TRL [1]. Designing and manufacturing quality into the product, increases reliability and substantially reduces cost. Since propulsion is a major component of recurring launch cost, such improvements result in reliability and a lower launch service cost[7]. It gives information about to offer its customers flexible, low-cost, and on-demand launch services[3]. Any satellite launch mission is a complex and expensive process and great care and precautions need to be taken for a safe and successful launch. A lightning stroke can be hazardous to the satellite launch system. Therefore extensive care has to be taken to protect the satellite launch pad against lightning. The paper aims at evaluating the efficacy of the aerial receptor system of the lightning protection scheme employed for protecting the Indian satellite launch pad. Significant upward leader activities are expected from tall objects during the approach of the descending leader and therefore any method that is employed for evaluating their attractive radii must take into account the different process involving and connected with the breakdown of air [5]. The developmental aspects of the sophisticated inertial sensors, inertial systems, associated complex electronics, on-board computers, control actuators and systems are reported. The complexity of the on-board control and guidance software and the test and evaluation procedures used for their validation are included. The general scheme of the inertial guidance systems and the critical role played by them in the realization of Indian satellite launch vehicles SLV-3, ASLV and PSLV are presented in

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 7, July 2016

brief[4]. Chemical process safety during rocket launch, piping systems that seemed to have resulted from shortcomings in inspection, testing, and quality control of piping materials [10]

VII. NEED FOR MAINTENANCE STRATEGIES

A. PLANNED MAINTENANCE

Planned maintenance is planned, scheduled and documented to be performed before breakdowns occur. Planned schedule maintenance: These activities are planned in terms of the maintenance operation and in terms of their timing. Planned unscheduled maintenance: These are occurs where the maintenance plan for equipment is to wait for break-down before performing maintenance[9].

B. PREDICTIVE MAINTENANCE

Predictive maintenance is a technique, are designed to determine condition of in-service equipment. By this technique predict when maintenance required. Two aims of predictive maintenance: First, to predict when equipment failure may occur and second, to prevent failure by performing required maintenance. Example of predictive maintenance vibration analysis in this predictive maintenance technique using a vibration analyzer, readings are taken from different points on the machine. These readings are accurate measurements of the vibration amounts produced by the moving parts of the machine. These vibrations and frequencies are help to find parts which need adjustment or replacing, and also help to identified what internal parts are causing problems. Internal parts are bad bearings, poor coupling alignment and excessively worn gears and many other mechanical problems can cause excessive vibration. [9]

C. PREVENTIVE MAINTENANCE

Preventive maintenance (PM) is a planned maintenance activity which is designed to improve equipment life and eliminate any unplanned maintenance activities. Preventative maintenances are performed while the equipment is still working condition, so that unexpectedly it does not break down. Preventive maintenance is the foundation of the whole maintenance strategy. [8]

Preventive maintenance includes:

- a) Inspection
- b) Detection
- c) Correction
- d) Prevention of emergent failures

Examples of preventive maintenance, components are inspected for corrosion and other damage at planned intervals, in order to identify corrective action before failures occur actually. Preventive maintenance performed at regular intervals usually results in reduced failure rates. This maintenance includes:

- a) Adjustments
- b) Cleaning
- c) Lubrication
- d) Repairs
- e) Replacements
- f) Extension of equipment life.

D. CORRECTIVE MAINTENANCE

Corrective maintenance is a maintenance operation performed to identify, separate and rectify a particular fault. This is performed to restore the failed equipment, machine or system to an operational condition. Corrective maintenance may be planned or unplanned. In planned corrective maintenance is a result of run-to-failure maintenance plan, while unplanned corrective maintenance could be due to a breakdown (not stopped by preventative maintenance), or a breakdown due to unperformed maintenance plan. Corrective maintenance performed due to condition monitoring program is planned maintenance. [9]

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 7, July 2016

VIII. EXISTING STRATEGIES

Maintenance of Rocket Launching System proactive in nature due to their operational complication, desired outputs etc. At present the existing strategies used in Indian launching system facilities for all the sub-systems like Cranes, Elevator, Folding cum Vertical Repositionable platforms, horizontal side doors, etc. is periodic preventive maintenance (PPM) is used to slow the degradation process and extend system life (egg, lubrication of mechanical systems). To maintain the utmost reliabilities and efficiencies during launching appropriate lubrication becomes the need before the launch. Prior to rocket launching the operational environment changes drastically leading to severe thrust on the launching platform, realising of undesirable and harmful gases, undesirable noise disturbance and sudden rise of temperature etc. Before commencement of any launching integration all the systems undergo periodic preventive maintenance followed by functional checks and test and evaluation of the systems. After ensuring satisfactory operations only the systems are put into usage for integration of launch vehicles. The types of lubricating agents are predefined in the maintenance procedure & chart of each system. It requires 20-25 days for complete maintenance. All the essential spares for each system are well planned in advance to meet periodic or breakdown requirements. So all the system are very well maintained periodically ensuring, their expected performance during operations.

IX. CONCLUSIONS

The maintenance process has been described addressing the challenges of responsive space and mitigating the risk of schedule slippage required thorough understanding of the various factors driving the development schedule of space system. The conclusions can summarise is Significance and impact of maintenance strategies on Rocket Launching System. Effective and more reliability used for rocket system to achieve the needs for best results.

REFERENCES

1. Cornford, Steven L., and Liam Sarsfield. "Quantitative methods for maturing and infusing advanced spacecraft technology." In Aerospace Conference, 2004. Proceedings. 2004 IEEE, vol. 1. IEEE, 2004.
2. Dubos, Gregory F., and Joseph H. Saleh. "Spacecraft technology portfolio: Probabilistic modeling and implications for responsiveness and schedule slippage." Acta Astronautica 68, no. 7 (2011): 1126-1146.
3. Fagan, D., F. McInerney, C. Johnston, and B. Tolson. "Kistler reusable vehicle facility design and operational approach." Acta Astronautica 52, no. 7 (2003): 563-573.
4. Gupta, S. C., and B. N. Suresh. "Development of navigation guidance and control technology for Indian launch vehicles." Sadhana 12, no. 3 (1988): 235-249.
5. Kumar, Udaya, and Nelson T. Joseph. "Analysis of air termination system of the lightning protection scheme for the Indian satellite launch pad." In Science, Measurement and Technology, IEE Proceedings-, vol. 150, no. 1, pp. 3-10. IET, 2003.
6. Launch Complex 39, Pads A and B. NASA KSC 1992.
7. MacLaren, A. J., and H. D. Trudeau. "Solid rocket motor space launch vehicles." Acta Astronautica 30 (1993): 165-172.
8. Harvard Mäki, Kari M. A Model for Maintenance History Data Management. Tampere.Tampere University of Technology. Department of Mechanical Engineering. Machine Design Laboratory. (2000).
9. Ait-Kadi, Daoud, Salih O. Duffuaa, Jezdimir Knezevic, and Abdul Raouf. Handbook of maintenance management and engineering. Vol. 7. London: Springer, 2009.
10. Sanders, Roy E. Chemical process safety: learning from case histories. Butterworth-Heinemann, 2015.
11. Satish Dhawan Space Centre en.wikipedia.org/wiki
12. www.isro.gov.in/applications