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(This section must be signed)

Individuals **outside your company**, including the companies listed above and other third parties, potentially including your competitors and others in your industry, may receive and/or review award submissions. All information submitted should address the program's management, leadership, and processes in a manner that you are comfortable sharing with third parties freely and without restriction, and may not include any classified or proprietary information or materials. Do not include any materials marked Confidential or Proprietary or bearing any similar legend. All responses and other submissions, whether in whole or in part ("Submissions"), shall be deemed not to be confidential, proprietary, and/or nonpublic information of any sort for any purpose.

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Acknowledged, agreed, and submitted by

RANDALL G KEMPTON Digitally signed by RANDALL G KEMPTON Date: 2023.05.30 16:11:00 -07'00'

Nominee's Signature _____ 5/26/2023 Date

Nominee's Name (please print): Randy Kempton

Title (please print): Executive Director, Strategic Engagement Systems

Company (please print): Raytheon Technologies

NOMINATION FORM

Name of Program: Standard Missile-3 Block IIA JFTM-07 Build and Test

Name of Program Leader: Randy Kempton, Paul Borboa

Phone Number: 520.582.5392 (Randy Kempton); 520.794.4667 (Paul Borboa)

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☒ Customer Approved

- Date: 5/8/2023
- Customer Contact (name/title/organization/phone): Nancy Jones-Bonbrest, Public Affairs Specialist, Missile Defense Agency (MDA), (571) 231-8211

☐ Supplier Approved (if named in this nomination form)

- Date: _____
- Supplier Contact (name/title/organization/phone): _____

PLEASE REFER TO PROGRAM EXCELLENCE DIRECTIONS AS YOU COMPLETE THIS FORM.

EXECUTIVE SUMMARY: Make the Case for Excellence *(Value: 10 points)*

What is the vision for this program/project? What unique characteristics and properties qualify this program for consideration?

Designed for exo-atmospheric intercepts of rogue nation medium to intermediate range ballistic missiles, the Standard Missile 3 (SM-3) Block IIA interceptor is the most successful and technologically-advanced US-Japan cooperative development program ever attempted. From initial joint requirements development to final operational testing, the SM-3 Block IIA Government (Missile Defense Agency and Japan Ministry of Defense Acquisition Technology and Logistics Agency), and industry (Raytheon Technologies and Mitsubishi Heavy Industries) teams overcame language, cultural and procedural barriers to create the most capable sea-land ballistic missile interceptor ever fielded, demonstrating capacity against threats well beyond its original design.

A Standard Missile-3 (SM-3) Block IIA is launched from the Japanese Ship MAYA as part of Japan Flight Test Aegis Weapon System -07 (JFTM-07). Image source: Missile Defense Agency.

In November 2022, the team accomplished two significant missile defense milestones during Japan Flight Test Aegis Weapon System - 07 (JFTM-07) conducted off the coast of the Pacific Missile Range Facility, Hawaii. This two-week mission demonstrated Japan's first multi-ship complex Integrated Air and Missile Defense (IAMD) capability. In partnership with the Missile Defense Agency (MDA), Japan Ministry of Defense Acquisition Technology and Logistics Agency, and the United States Navy, the team conducted two live fire intercept exercises to certify the ship's combat systems and crew. In the first intercept event, the Japanese Ship (JS) MAYA (DDG-179), the first ship in Japan's newest class of DDG, tracked and intercepted a medium range ballistic missile target with an SM-3 Block IIA, marking Japan's first ever SM-3 Block IIA missile launch and intercept.

The second intercept exercise demonstrated a complex Integrated Air Missile Defense (IAMD) scenario highlighting simultaneous defensive capabilities against a short-range ballistic missile and air breathing cruise missile targets. For this event, the JS HAGURO (DDG-180) successfully engaged the threat targets with SM-3 Block IB and SM-2 Block IIIB missiles.

JFTM-07 was a capstone achievement validating this amazing defensive capability. "The success of this joint test marks a critical milestone in demonstrating, for the first time, a live fire of an SM-3 Block IIA from a Japanese ship," said MDA Director Vice Adm. Jon Hill. "The cooperative development of the SM-3 Block IIA by the Japanese government, U.S. government and industry team, and the integration with the Aegis Weapon System on Japan's Ballistic Missile Defense-capable ships, is a remarkable achievement and vitally important in defending against an ever-increasing threat. I congratulate the Japan Maritime Self Defense Force, U.S. Navy, MDA team, and our industry partners on this accomplishment."

Raytheon Technologies is proud of the relationship and trust earned with the MDA, the Japan Maritime Self-Defense Force, the United States Navy and Mitsubishi Heavy Industries (MHI). Raytheon looks forward to building upon this success in the future. Throughout the manufacturing and delivery of JFTM-07, the SM-3 team demonstrated the ability to overcome numerous challenges and difficulties. The joint team has proven through JFTM-07 that they were up to the challenge.

DIRECTIONS

- **Do not exceed 10 pages in responding to the following four descriptions**.
  - Allocate these 10 pages as you deem appropriate, but it is important that you respond to all four sections.
- DO NOT REMOVE THE GUIDANCE PROVIDED FOR EACH SECTION.
- Use 12 pt. Times Roman typeface throughout.
- Include graphics and photos if appropriate; do not change margins.

VALUE CREATION

Value: 15 points

Please respond to the following prompt:

➢ **Clearly define the value of this program/project for the corporation; quantify appropriately**

The SM-3 Block IIA program is a franchise program in RTX's missile defense portfolio. It leverages the best of Raytheon's history of kinetic warhead development and demonstrates our advanced technology integration expertise as the first program that was co-designed and developed with the Japanese, overcoming significant language, cultural and industrial barriers. The unprecedented 20 year plus joint program expanded Raytheon's engineering and production expertise, creating new business alliances and new capabilities to counter advancing threats. The SM-3 Block IIA program combines world class U.S. and Japanese production facilities providing unparalleled benefits to both the individual program as well as serving to increase the overall knowledge within this complex mission space. The knowledge sharing is not limited to traditional key component manufacturing but spans all the advanced industries aspects of both countries to include security, logistics, government oversight, and testing, to name a few. RTX completes final integration of all components into the SM-3 Block IIA All Up Round creating an interceptor that has demonstrated capability well beyond its original scope as demonstrated by its successful intercept of an intercontinental ballistic missile target.

➢ **Clearly define the value of this program/project to your customer**

The MDA's mission is to "… develop and deploy a layered Missile Defense System to defend the United States, its deployed forces, allies, and friends from missile attacks in all phases of flight." The SM-3 Block IIA missile is the most advanced ballistic missile interceptor in production today and is a cornerstone to MDA's layered mission. Operationally, JFTM-07 not only confirmed the SM-3 Block IIA and SM-3 Block IB missile's layered defense architecture, but it also validated the US-Japan industry's potential to design-develop advanced technology and Raytheon Technologies integration experience.

Missile Defense Agency, Defense Contracting Management Agency, and RTX SM-3 Leadership Team

Our joint team tested two unique scenarios, to include the first successful engagement of a SM-3 Block IIA fired from Japanese ship against a medium range ballistic missile target. The second exercise demonstrated a successful integrated air and missile defense scenario using SM-3 Block IB and a SM-2 Block IIIB missiles fired from the JS HAGURO against a short-range ballistic missile target and an Anti-Air Warfare engagement. These unique and increasingly complicated tests undoubtedly prove the power of the value of SM-3 to MDA and our country.

- **Clearly define the value of this program/project to members of your team; quantify if possible**

Raytheon Technologies has been recognized for its Kill Vehicle Center of Excellence, producing the critical technologies for EKV and SM-3 Block IB, but with the addition of SM-3 Block IIA, the Raytheon SM-3 team has increased its scope to enable the incorporation of the most advanced technologies from the U.S. and Japan. The expanded team exemplified unparalleled partnership throughout the design, development and initial manufacturing stages of the Standard Missile-3 Block IIA Cooperative Development Program (SCD) and throughout its initial production. The first of its kind co-development yielded not only a spectacular interceptor, but a unique industry to industry relationship between Raytheon Technologies and Mitsubishi Heavy Industries, that enabled new strategic, technical and collaborative working groups.

While Raytheon Technologies was contracted as the prime integrator, MHI served as the Japan lead integrator for Japanese suppliers and technology. Together, they jointly addressed all issues regarding design, manufacture, and sustainment of a missile that is vital to U.S and Japanese national security. The SM-3 team takes a tremendous amount of pride in knowing that their work allows the United States, its allies, and almost every part of the globe to be protected.

In early November 2022, during a ceremony commemorating the 500th SM-3 delivery across the IA/IB/IIA variants, RTX SM-3 Executive Director, Randy Kempton, said “Many thousands of people have contributed their time and talent to the SM-3 program for two decades and counting. Because of their efforts, we are able to gather here today, knowing that we are protected by such a capable interceptor.”

Reflecting on SM-3, he said “Having worked together on this critical defense program from initial concept to final certification testing, overcoming major industrial challenges as a team cannot be duplicated without significant investment in time and resources. When the SCD was initiated, the focus was on technical possibilities. Only through actual execution could we discover all the challenges we would face. As a result, we fully understand what it takes to do a cooperative effort of this nature and have an established end to end processes and procedures to address all the ‘gotchas’ from security, logistics, management of discrepancies, testing, and corrective actions. The SM-3 Block IIA program brings the best capabilities of the U.S. and Japan together, creating a robust design-production capacity that is ready to take on the toughest challenges.”

The RTX Huntsville Production Team. RTX delivered the 500th SM-3 missile to MDA in November 2022.

- **Clearly define the contribution of this program/project to the greater good (society, security, etc.)**

SM-3 Block IIA being loaded onto the Japanese Ship MAYA, DDG 179.

In a dynamic world filled with rogue and near peer nations threatening others with the use of force at increased frequency, the SM-3 program provides the U.S. and allies with a proven defensive capability and sense of security. JFTM-07 substantiated the interceptors, the feasibility of the Aegis architecture, and readiness of one of our most trusted allies.

Raytheon Technologies' noble vision statement is "One global team creating trusted, innovative solutions to make the world a safer place." With advanced technologies and the incredible government/industry workforce coming together from the U.S and Japan, the SM-3 Block IIA missile is the most advanced ballistic missile interceptor in production today. SM-3 has demonstrated more exo-atmospheric intercepts and sea/land test configurations that any other ballistic missile interceptor giving those that defend our countries the confidence to face their greatest challenges to help make the world a safer place.

ORGANIZATIONAL BEST PRACTICES AND TEAM LEADERSHIP

Value: 35 points
Use 12 pt. Times Roman typeface

Please respond to the following prompts:

- ***15 points:*** **Describe the innovative tools and systems used by your team, how they contributed to performance and why**

For a mission of such great importance – for our national security, those that defend our countries and global stability – it was essential that all conceivable risks and anomalies that might occur in flight were anticipated and addressed prior to the launch decision. To that end, the customer and the industry team utilized a demonstration unit and tirelessly worked in unison to create a strategy and test plan that would accurately quantify the risk. This demonstration unit was built with representative hardware and preceded the flight round through assembly at all the novel processes. The demonstration unit represented a great example of customer and industry collaboration, given that the two teams of technical experts had to work together to determine which steps in the process would need to be highlighted, what the test plan would look like, and where the larger team needed to stop to make sure all the processes performed as expected.

The use of the demonstration unit was just one example of how the combined government/industry teams worked together to ensure the SM-3 Block IIA missile would be completed to support the mission. Whether it was through assembly and test planning, defect and issue resolution, broader organizational communications, or leveraging support from the larger defense and industry community (suppliers and defense logistics services), the JFTM-07 build proved once again that the mission is a shared mission, in which everyone has a part to play.

Though the utilization of the demonstration unit was a critical component to the overall strategy, it was an additional unit that the congested assembly line had to account for. Its unique assembly and test flow required significant forethought and planning between multiple program teams and factory leadership to accommodate. The unit leveraged representative engineering hardware that was built up into a Kinetic Warhead, which was then shipped to the all-up round facility in Huntsville for integration onto an Inert Operating Missile (IOM). The unit completed all the required testing at that level and then was torn down to the Guidance Unit level and shipped back to Tucson. Once in Tucson the unit was run through the Computer-In-the-Loop (CIL) lab, where the test equipment simulated a fly-out scenario. This testing was performed to ensure that the Guidance Unit, the brains of the missile where the important flight software is loaded, performed as expected.

Given the compressed schedule for building the actual JFTM-07 flight test missiles, the factory had to optimize the assembly flow in a manner where the actual missile build immediately shadowed the demonstration unit, proceeding to the next step in the process almost immediately after the demonstration unit satisfactorily passed through its phase. This adaptation to the actual build process represented flexibility and significant teamwork that was made possible by utilizing all of the factory team's skills and intangible production experience from decades of missile integration.

BEST PRACTICE TOOLS

- DEMONSTRATION UNIT
- SUPPLIER COLLABORATION
- SPECIAL TEST REQUESTS
- PEOPLE – EXPERIENCE & DEDICATION

- ***10 points:*** **How did you leverage skills and technologies of your suppliers?**

Special Test Request Process

One of the RTX tools that proved to be valuable during the JFTM-07 build was the use of the Special Test Request process. The process provides a framework for developing unique tests that are inserted into the traditional build process and become part of the build's quality history record. These tests can be developed to verify the functionality of a change to the hardware (most typically for software changes) or re-run segments of test to analyze data. The test plan is developed in collaboration between the Engineering and Operations teams. It is then peer reviewed and approved by the chief engineer and lead quality representative. It is a valuable process for performing testing that is not part of the typical work instructions for an assembly and ensures that the procedure receives the same rigor and review that the established instructions do.

For the JFTM-07 round, the Special Test Request process was used multiple times. One such occasion dealt with the re-keying (called re-KLIF) of the GPS receiver used in the unit. The GPS receiver is the device that facilitates communications between the missile, the satellites and the ground-based radar used to track the missile to its target. The frequency is encrypted, or uniquely keyed, to prevent the signal from being tampered with or intercepted. For the JFTM-07 mission, since the missile was firing off a foreign ship, the receiver had a different set of keys than what is normally programmed by the supplier.

RTX Engineering had to work with the supplier to provide and re-program a set of GPS Receivers with the new keys. Once the newly re-KLIF'd receivers were delivered to RTX the engineering team had to develop a process to verify the functionality of the GPS Receiver with the new keys, prior to proceeding with install into the JFTM hardware.

The team resurrected a special set of test equipment that had previously been used to simulate a "Live Sky" condition. This condition is a process where the unique keys are loaded onto the test equipment and

then transferred to the unit. The test equipment and unit under test requests data from the overhead satellite constellation (via an antenna on the roof of the lab). The test equipment then feeds it back through the unit under test, just like it would in an actual mission. Under normal production builds this "Live Sky" process does not occur until all up-round assembly in Huntsville. But the team wanted to be sure this functionality was working much earlier in the process. This is where the Special Test Request comes in.

The Engineering team worked together to generate test equipment software to facilitate the test, devise a test plan, generate the Special Test Request, and have it peer reviewed and approved by key personnel. They then executed the test in the lab and demonstrated the needed functionality in the GPS receiver. Normally, instituting this type of process would take months. But leveraging extra hours, additional personnel, and determination the team stood-up and executed all of it in a matter of weeks, where no process or capability had existed before. When the test was completed successfully Missile Manager of Missile (MOM), Kathleen Judnich recalls jumping up in the middle of the lab and raising her hands in triumph.

Missile MOM, Kathleen Judnich (center), with the factory team and the JFTM-07 Block IIA flight test round.

"We were all very excited and fulfilled," said Judnich. "There really are few greater feelings in our profession than taking on a hard problem with a great group of people and seeing it through to completion."

- ***10 points:*** **Define the unique practices and process you used to develop, lead and manage people?**

Ultimately all challenging efforts and great achievements are the culmination of a thousand little actions taken by a group of people doing the work, day in and day out. It takes people who accept challenges, have the experience, and possess a dedication to the mission. The people supporting the IIA program – the factory technicians, the engineers, the program leadership, committed foreign partners, and colleagues in the customer community - were the glue that held it all together.

The RTX leadership team strives to make SM-3 a magnet for talent and retention – emphasizing the importance of the mission and the pride that this instills. They do this through things like the SM-3 Culture Council, which plans and coordinates employee appreciation events and provides a voice for organizational improvement to senior leadership. The executive director also conducts monthly all-hands with the entire SM-3 portfolio where he seeks input from any and all members and endeavors to take on the tough questions.

Many on the industry and customer teams have spent the majority of their careers in the SM-3 family. It's not uncommon to have individuals in the program that were present when the very first SM-3 Block IAs rolled off the assembly line or who played a central role in setting up and executing the initial developmental collaboration with Japan and MHI. This has created a unique bench strength and depth of understanding of the unique challenges often faced in this environment.

Kathleen Judnich is a good example. She started her career as a data analyst in the SM-3 labs, then moved to facilitating the JFTM effort, and is now the flight test lead on the Glide-Phased Interceptor (GPI) effort. GPI leverages legacy SM-3 technology and hardware, as well as the AEGIS platform, in developing an important counter hypersonic solution for the United States. Leveraging years of experience provides Raytheon and its partners with the hard-earned experience required to fulfill the important mission of keeping the nation safe.

DEALING WITH PROGRAM COMPLEXITY
(VOLATILITY, UNCERTAINTY, COMPLEXITY, AMBIGUITY, or VUCA)
Value: 25 points
Use 12 pt. Times Roman typeface

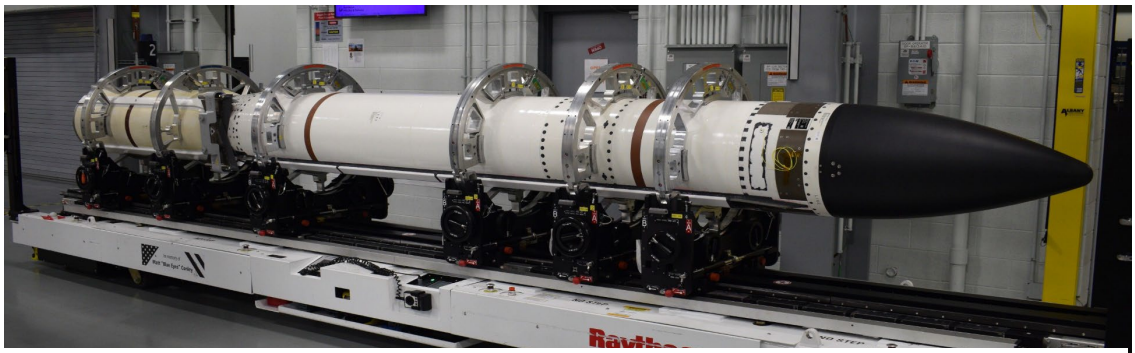
Please respond to the following prompts:

- ***10 points:*** **Describe UNIQUE areas of VUCA faced by your program and why. (Please avoid the issues surrounding Covid-19 pandemic, which was faced by all programs.)**

The JFTM missile was the very first missile of a new configuration. With a missile of this complexity, anytime a new configuration is being processed through the factory, it requires a number of "firsts". In this specific instance, there was new embedded missile software and test equipment software, as well as dozens of new drawings, which drove changes to process documentation. In addition, there were new procedures and testing steps added.

Because the configuration changes effected such a low-level assembly it meant that drawing and process step revisions, and test equipment software upgrades effected six major assembly levels in three different factories in two different locations (Tucson and Huntsville). Each of these process deviations triggered validation runs of the software with engineering hardware, hours of documentation updates and data compilation, and multiple board reviews. Under normal circumstances, this process often takes as long as 15 months to accomplish. But due to delays in the supply chain, the team had to realign scheduling and processes to complete the task in less than nine months.

The factories had the added challenge of running this critical hardware across a shared production line operating at full capacity. Both the Tucson and Huntsville factories were simultaneously processing several domestic SM-3 Block IIA hardware assemblies amidst test equipment software upgrades-which subsequently required employee retraining. Despite the challenges, management teams were successful in carving out a path to execute the accelerated JFTM-07 schedule while not impacting the forward flow tactical rounds.



SM-3 Block IIA in final assembly at Raytheon Redstone Missile Integration Facility, located in Huntsville, Alabama.

The supply chain constraints also impacted the Engineering team's ability to have the hardware on-hand to support the needed validations of the embedded software for the missile. This meant that at the beginning of missile assembly the required embedded software had not completed its final qualification test. The Engineering and Operations teams needed to work together to enable building-at-risk while the software team, in parallel, completed the final qualification test.

Lastly, the new configuration carried with it several new requirements. One such example was the implementation of the SMC-S-016 (Space and Missile Systems Command (MSC) Center Standard) enhanced testing regimen. The standard establishes additional environmental and structural testing requirements for space vehicles. These additional requirements, being performed for the first time on production hardware, increased the overall cycle time of the assembly by as much as two weeks.

The program, Engineering, and Operations teams were faced with the daunting task of accomplishing more than double the nominal work for completing a missile in nearly half the time, all the while making sure it was built with the highest standards of quality and with all the oversight that comes with a flight test missile.

"This was a fine example of our team, leveraging diversity of thought and innovation, coming together to achieve the seemingly impossible," said RTX SM-3 Block IIA Program Manager, Cedric Macadangdang. "When the odds were against us, the team's motivation to succeed, driven by the importance of such a noble mission allowed us to remove any barrier that stood in the way of achieving our goals and delivering world-class capability to our warfighters."

SM-3 IB and IIA missiles being loaded onto a C-17 aircraft at Redstone Arsenal, Alabama, in preparation for JFTM-07.

- ***15 points:*** **Explain how your team responded to these challenges. What changes did you make, what were the results?**

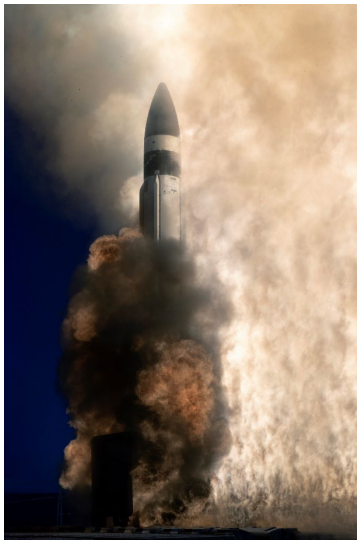
The team used a number of different strategies to execute in a condensed schedule. Early on the team recognized that they could not complete the manufacture of the guidance electronics unit in the Avionics factory without greatly impacting the current domestic IIA production going on in parallel. This was due to the need to complete prove-ins on all the test equipment, which would require several days where the equipment would not be available to forward flow production.

The team decided to shift the manufacture of the guidance electronics to the Environmental Test Lab. This lab was where the new unit configuration was qualified and maintained a great deal of the infrastructure required to complete the assembly. It was, however, an engineering lab and not a certified production area. The team engaged manufacturing, quality, and worked side-by-side with the customer to "productionize" the lab environment.

The team leveraged an existing RTX process for converting labs to production areas, which included a Tier II Checklist. This checklist described all the areas, from ESD protocols to FOD prevention measures, and everything else in between that drives a high standard of excellence and accountability expected of a facility producing critical hardware. In collaboration with the customer, the cross-functional team

completed recurring audits of the lab environment to understand gaps and track them to closure, prior to releasing the area for production.

"In the manufacturing world there will inevitably arise issues that cause you to have to deviate from the ideal plan," said Cindy Maestas, the RTX Program Operations Manager for SM-3 Block IIA. "The team really came together to provide another option, which enabled us to meet the accelerated schedule demands for the JFTM while not sacrificing the important processes that ensure we make the highest quality hardware."



A SM-3 Block IB is launched from Japanese Ship HAGURO, durnig the second JFTM-07 event. Image source: Missile Defense Agency.

The next critical hurdle was to put a process and the necessary controls in place to allow for the assembly and test of the hardware while the software team completed the final qualification test. Under normal circumstances the manufacturing team would not move forward with the assembly without that test being complete and the drawings locked down. But the condensed schedule would not allow for this.

The team leveraged internal RTX processes for "build-at-risk" utilizing liens and variances against the hardware which interfaced with the enterprise workbench system (PRISM) that is used to track completed operations as part of the assembly and test process. These processes are reviewed and approved by a cross-functional team of stakeholders (to include Quality, Operations, and Engineering) and allow for the forward process of hardware to a certain point, while engineering efforts are underway in support of releasing approved technical data packages or defect disposition is performed.

For each test in the process the team instituted test data reviews. Given the build-at-risk approach, it was critical to ensure that the hardware was being tested correctly and no anomalies were observed. At the completion of each test the engineering team collected all the data generated as a result of the test and conducted this review with a panel of experts, to include the customer. The hardware could not proceed to the next level or operation until the test data reviews were conducted and the panel gave the go-ahead.

The team would have to use this "build-at-risk" process again when, with one month to go until missile delivery, a non-conforming condition was discovered on a large effectivity of a specific low-level sub-tier supplied part that was used in a dozen circuit cards within the JFTM missile hardware. At this point the rework to replace these deeply embedded circuit cards would have been impossible to complete in the timeframe needed to support the planned test flight date. The team levied defects on the hardware and allowed it to move forward while the Engineering team spearheaded risk assessments on the specific components in the JFTM missile. The risk assessment activity represented a massive, unplanned effort, leveraging dozens of specialists and many hours of intense data analysis and compilation. This culminated in a Program Mission Assurance Board panel review, a group of independent specialists representing some of the brightest minds in the company, to provide the approval of the risk assessment and sell-off of the missile.

STRATEGIES:

- TIER II CHECKLISTS
- BUILD AT RISK
- CRITICAL PATH
- MISSILE MOM

Lastly, the team used all the tools and approaches that have been leveraged and tested from years of experience building SM-3 hardware in similar situations. These approaches included conducting morning stand-ups with the select team assigned to build this hardware and adopting the "critical path" methodology to address issues as they inevitably came up. The team also assigned a Missile MOM, or an empowered engineering authority to foster the product through the manufacturing process and address technical concerns.

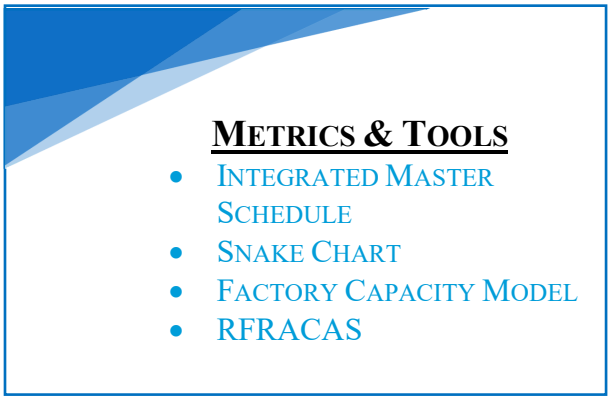
"The JFTM-07 round was under an incredible amount of scrutiny, both from within RTX and our customer," said Kathleen Judnich, the Missile MOM for the JFTM-07 round. "The international nature of this mission made it a highly visible event. The team worked together to achieve a common goal, overcame all of the hurdles, and persevered as demonstrated in a successful mission."

METRICS

Value: 15 points
Use 12 pt. Times Roman typeface

Please respond to the following prompts, where predictive metrics indicate items that provide a view of how yesterday's actions and today's actions will affect the future timeline, cost or other requirement.

- **What are your predictive metrics?**



The team leveraged a number of established tools and processes available to RTX to execute the multiple parallel activities to provide program management and the customer with a better understanding of progress toward the plan. It all starts with a plan – the Integrated Master Schedule. The schedule provides the one single plan the entire team executes to – developed in collaboration with the program and functional teams – it brought together all of the tasks that needed to be executed to ensure mission success. This schedule incorporated the multiple parallel activities (engineering prove-ins, assembly, test, supplied part receipt, documentation processing), complete with predecessors and successors linked to the corresponding activities. With this plan, the team could identify tasks that could happen in parallel to bring in schedule and perform critical path analysis to identify major constraints to ensure the right level of support and resources working those issues. Historical performance (such as average manufacturing actuals for the relevant operations in the manufacturing flow) where incorporated into the data set to provide the team with an executable baseline from which to draw the action plan.

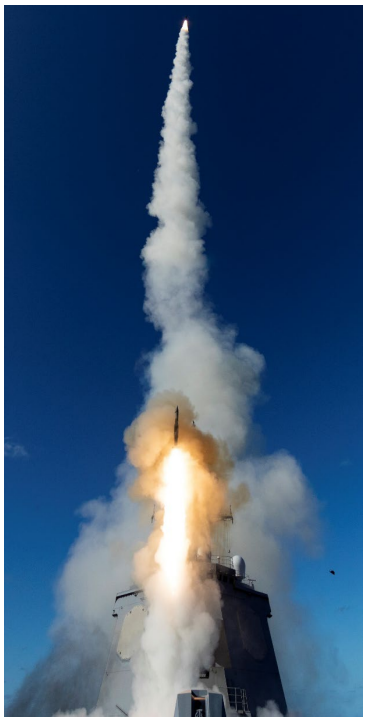
The high-level output of the Integrated Master Schedule that could be used to manage the day-to-day execution and communicate the status of the missile-build was a macro-enabled, easy to understand, snake chart outlining the key operations, estimated completion dates, and current status. The snake chart could be updated in real-time to incorporate the latest developments. If a certain operation, or planned activity, was trending outside the proposed plan, the snake chart contained conditions which would cause it to turn yellow or red, indicating an issue or schedule risk that needed to be addressed. This together with leveraging schedule risk assessment tools, would help the management team provide the right level of focus and support to ensure roadblocks were removed and areas of high-risk to schedule were mitigated.

The manufacturing team also leveraged a number of other supplemental factory management tools to augment the outputs of the snake chart. This included utilization of a factory capacity tool, developed by the industrial engineering team, to help plan out the build through the value stream and address any predicted bottle-necks at various operations or assembly stations. Another valuable tool was the RTX Failure, Reporting, Analysis and Corrective Action System. This database provided a running history of test data and failures, broken down by assembly, operation and documented corrective actions. Having this running history allowed the team to anticipate potential test failures as the hardware moved through the factory and prepare corrective actions or dispositions in advance.

- **How did you perform against these metrics?**

Given the many challenges of the JFTM-07 build and the condensed timeframe for completion there were often times that the snake chart was communicating conditions that would forecast a late-to-need completion of the missile. Plans rarely go to plan. But the importance of having a plan from which to baseline the effort provides the invaluable foundation for knowing when and where to push. By looking at an out-of-bed completion date the team was able to better understand just how far out of bed they were, where the long-cycle times were driving completion to that date, and where the opportunities where for gaining back time.

By having a database of cycle-time data by operation the team could see where certain operations often were performing under the average historically, study why that happened, and how to repeat it for the JFTM effort, whether it be through use of weekend overtime, extended or overlapping shifts, utilization of specific manpower, or leveraging parallel operations in assembly.



SM-3 Block IB and SM-2 Block IIIB fired from the JS HAGURO. Image source: Missile Defense Agency.

- **How do your predictive metrics drive action toward program excellence? Please provide examples.**

The snake chart became the primary scheduling and status tool that was used across the program, by all functions and working teams supporting the many on-going, overlapping activities in the overall effort. Its easily understood interfaces made it an effective communications tool, not only for the working teams, but also for status flow-ups to senior leadership and on the daily briefs with the customer community.

Each morning the snake chart would be updated by the Operations lead with the accomplishments from the previous day. The chart would then be presented in the morning program stand-up, where program leadership and all the important functional leads were present. Everyone would leave that meeting with a clear understanding of where progress was halted, and help was needed. Actions were developed and teams were tasked to address the obstacles. The snake chart was then saved in the program shared drive freely accessible to any of the diverse teams across the program working various parts of the effort. Any team member could pop into the shared drive and see the status of at any time. The tool became the galvanizing center-point of the entire JFTM-07 effort.