Selected Acquisition Report (SAR)

LGM-35A Sentinel (LGM-35A Sentinel)

FY 2024 President's Budget

Defense Acquisition Visibility Environment (DAVE)

Table of Contents

Common Acronyms and Abbreviations

$B - Billions of Dollars
$K - Thousands of Dollars
$M - Millions of Dollars
ACAT - Acquisition Category
Acq O&M - Acquisition-Related Operations and Maintenance
ADM - Acquisition Decision Memorandum
APB - Acquisition Program Baseline
APPN - Appropriation
APUC - Average Procurement Unit Cost
BA - Budget Authority/Budget Activity
Blk - Block
BY - Base Year
CAPE - Cost Assessment and Program Evaluation
CARD - Cost Analysis Requirements Description
CDD - Capability Development Document
CLIN - Contract Line Item Number
CPD - Capability Production Document
CY - Calendar Year
DAB - Defense Acquisition Board
DAE - Defense Acquisition Executive
DAMIR - Defense Acquisition Management Information Retrieval
DoD - Department of Defense
DSN - Defense Switched Network
EMD - Engineering and Manufacturing Development
EVM - Earned Value Management
FMS - Foreign Military Sales
FOC - Full Operational Capability
FRP - Full Rate Production
FY - Fiscal Year
FYDP - Future Years Defense Program
ICE - Independent Cost Estimate
Inc - Increment
IOC - Initial Operational Capability
JROC - Joint Requirements Oversight Council
KPP - Key Performance Parameter
LRIP - Low Rate Initial Production
MDA - Milestone Decision Authority
MDAP - Major Defense Acquisition Program
MILCON - Military Construction
N/A - Not Applicable
O&M - Operations and Maintenance
O&S - Operating and Support
ORD - Operational Requirements Document
OSD - Office of the Secretary of Defense
PAUC - Program Acquisition Unit Cost
PB - President's Budget

PE - Program Element
PEO - Program Executive Officer
PM - Program Manager
POE - Program Office Estimate
RDT&E - Research, Development, Test, and Evaluation
SAR - Selected Acquisition Report
SCP - Service Cost Position
TBD - To Be Determined
TY - Then Year
U.S. - United States
UCR - Unit Cost Reporting
USD(A&S) - Under Secretary of Defense (Acquisition and Sustainment)
USD(AT&L) - Under Secretary of Defense (Acquisition, Technology and Logistics)

Program Information

Program Name

LGM-35A Sentinel (Sentinel)

DoD Component

Air Force

Responsible Office

Program Manager

Name: Col Charles A. Clegg
Date Assigned: July 2022
Address: 6008 Wardleigh Road
Building 1580
Hill AFB, 84056
Phone: (801) 777-1776

Mission and Description

The Ground Based Strategic Deterrent (GBSD) program is a full recapitalization of the Minuteman (MM) III Intercontinental Ballistic Missile (ICBM) weapon system, which includes 400 deployed missiles, associated spares, and 450 launch facilities (LF). The replacement program includes new missile systems, new command and control systems, ground systems, and the conversion of the MM III silos and Launch Control Centers. The GBSD weapon system will be designed to be operationally capable through FY 2075. The program's mission is to deliver the next generation of ICBM nuclear deterrence for America.

Executive Summary

LGM-35A Sentinel

Program Highlights Since Last Report

Sentinel continues to make progress through the Engineering and Manufacturing Development phase. The Northrop Grumman Corporation, with government team oversight, continues to mature the design, integrate all technologies and capabilities into a single system and prepare for weapon system manufacturing. Synchronizing the development and fielding of the Sentinel Weapon System and the associated military construction projects remains a top priority with activities taking place across seven states and five installations. The Sentinel program, like other major programs, continues to have challenges due to supply chain issues, parts availability, and the ability to hire qualified individuals to support program needs. Analysis of these challenges and the macroeconomic conditions related to construction materials are being evaluated against the Milestone-B Independent Cost estimate funding levels.

Sentinel is working to mitigate likelihood and impact of potential program delays due to the current macroeconomic environment affecting the industrial base. Sentinel is actively engaged with resolving identified risks and is conducting a schedule assessment. Sentinel and the Northrop Grumman Corporation are jointly focused on clear communication to facilitate schedule synchronization. Other efficiencies include transferring capabilities to the cloud to increase access points from other operating locations and to leverage a wider talent pool. Program efforts to address recruiting challenges include utilizing support contractors and Federally Funded Research and Development Center mission partners as well as establishing program office operating locations near acquisition and technical centers of excellence. FY 2023 MILCON cost escalations caused by the macroeconomics conditions were submitted to the Congressional Committees for inclusion in the FY 2023 Appropriations Bill. The program is still evaluating FY 2024 MILCON cost escalations within the existing Sentinel MILCON allocation.

Upcoming events include subsystem Critical Design Review (CDR) deliveries throughout FY 2023. The Post Boost Propulsion System will be delivered to support Flight Test-01. Multiple testing events include a simulated interface test with the Western Test Range, Stage 1 Static Fire Open Air tests and Interstage Separation Tests. Military construction continues for Sentinel Weapon System development, testing and to support the Warfighter.

There are no significant software-related issues with this program at this time.

Highlights:

- 1st Booster - Modal Test Asset (MTA): Stage 1 and Stage 2 assembled/completed; Stage 3 cure is complete; developing non-destructive test (NDT) standards in preparation for X-ray inspection as of December 20, 2022.
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- 2nd Booster - Static Fire 1 (SF-01) Assets: Stage 1 assembled/completed and at Promontory; Stage 2 inspection complete; at Promontory now awaiting assembly; Stage 3 NDT complete; working issue with forward dome delamination as of December 20, 2022.
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- 3rd Booster - Developmental Flight Test 1 (FT-01): Stage 1 propellant casting activities on hold pending completion of Stage 2 propellant cracking root cause corrective action; Stage 2 case hydro test is complete; working issue with surface-level fiber breakage; Stage 3 EPM trials underway as of December 20, 2022.
- Successfully held CDR for the 1/2 and 2/3 Interstages; this marks the first Level 3 CDR for the Sentinel program November 1-2, 2022.
- Successful completion of KS-75/Cryptographic Unit Test (CUT) Station Critical Design Review (CDR) w/Sandia National Lab August 23-24, 2022.
- The Sentinel Draft Environmental Impact Survey (DEIS) released 1 Jul 2022 for public review; public comments/ hearings concluded on August 16, 2022.
- Successful delivery to Northrop Grumman (NG) of all planned KS-75 prototype units - 22 in total August 5, 2022.
- Integrated Functional Capability (IFC) 0.5 software coded, and hardware delivered to NG June 17, 2022.
- Single Board Computer Developmental Unit CDR held April 26, 2022.
- Stage 1, 2, and 3 Booster Thrust Vector Control (TVC) CDR held March 29-30, 2022.
- Conducted Honeywell TVC system CDR March 29-30, 2022.

History of Significant Developments Since Program Initiation	
History of Significant Developments Since Program Initiation	
Date	**Significant Development Description**
Dec - 2022	The Office of the Secretary of Defense authorized the Department of the Air Force (DAF) to use the DX industrial priority rating in support of the Sentinel Weapon System to alleviate some prioritization issues caused by supply chain volatility.
Sep - 2022	NG delivered 29 Test Reports for Nuclear Hardness and Survivability (NH&S) parts characterization of electronic components for use in various subsystems throughout the weapon system.
Sep - 2022	Testing completed at Arnold Engineering Development Complex (AEDC) von Karman Gas Dynamics Facility (VKF) for sub-scale Stage 1 and 2 cold separation of the Aerospace Vehicle Equipment (AVE), wind tunnel testing of Stage 1 and 2 hot separation of the AVE, and NH&S parts characterization
Sep - 2022	The Nuclear Effects Advisory Panel's (NEAP) Combined Nuclear Effects Surrogate Testing (CNEST) final report was approved by Sentinel (GBSD) leadership and provided to OSD R&E stakeholders.
Aug - 2022	Successful completion of KS-75/Cryptographic Unit Test (CUT) Station Critical Design Review (CDR) w/Sandia National Lab
Aug - 2022	The Sentinel (GBSD) Draft Environmental Impact Survey (DEIS) was released July 1, 2022 for public review; public comments/ hearings concluded on August 16, 2022
Dec - 2021	SPO delivered the updated Test and Evaluation Master Plan (TEMP) to the Office of Secretary of Defense (OSD).
Nov - 2021	Program Office conducted sled test with Strategic Resonating Beam Accelerometer (SRBA) at Holloman AFB.
Oct - 2021	Enhanced Ground Test (sled test) conducted at Holloman AFB.
Oct - 2021	GBSD closed out the encryption preliminary design review with Sandia National Labs.
Sep - 2021	First GBSD Holloman High Speed Test Track mass-mock run.
Sep - 2021	The United States Government delivered VSFB Missile Alert Facility to NG.
Aug - 2021	The United States Government delivered Vandenberg Space Force Base (VSFB) Launch Facility to NG.
Mar - 2021	NG conducted an Integrated Baseline Review.
Sep - 2020	GBSD successfully awarded the EMD Contract on September 8, 2020.
Sep - 2020	MDA approved Milestone B on September 4, 2020.

Schedule

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Events	Milestone Baseline Objective	Current Baseline Objective/Threshold		Current Estimate/Actual	Deviation
Milestone B	Aug 2020	Aug 2020	Sep 2020	Sep 2020	
System Critical Design Review (CDR)	Jul 2023	Jul 2023	Jul 2024	May 2024	
Milestone C	May 2026	May 2026	May 2027	Jan 2026	
Initial Operational Capability	Jun 2029	Jun 2029	Jun 2030	May 2029	
Full Rate Production (FRP) Decision Point	Sep 2029	Sep 2029	Sep 2030	Jul 2029	

Schedule Note

Sentinel Risks are held at Controlled Unclassified Information Level.Sentinel is experiencing schedule pressures due to macroeconomics factors affecting the industrial base because of COVID-19. Volatility in the supply chain is causing increasing lead times for parts and components that are extending to commodities. These pressures eliminated margin or pushed forecasted major program events dates past their baseline. Sentinel Systems Directorate conducted a schedule assessment to explore opportunities to mitigate impacts to Initial Operational Capability (IOC) and Secondary Launch Platform-Airborne (SLP-A) capabilities. The "Current Estimate" dates as listed above are contractor estimates. A schedule assessment was completed and results were briefed to the Milestone Decision Authority (MDA) in 2nd Quarter FY 2023 at the In-Progress Review (IPR).

Performance

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Classified Performance information is provided in the classified annex to this submission.

Requirement Reference
GBSD Capabilities Design Document (CDD) June 18, 2019

Performance Note
Sentinel (GBSD) is tracking to meet or exceed all EMD KPP requirements. Sentinel tracks KPPs as defined in Capabilities Design Document.

Acquisition Budget Estimate

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Total Acquisition Cost

		Milestone APB	Current Baseline		Budget Estimate PB 2024		
Category	**Base Year**	**Objective (BY$M)**	**Objective (BY$M)**	**Threshold (BY$M)**	**BY$M**	**TY$M**	**Deviation**
RDT&E	2020	22,978	22,978	25,275.8	21,235.1	25,514.7	
Procurement	2020	47,858.4	47,858.4	52,644.2	43,546.4	61,593.1	
MILCON	2020	6,904.3	6,904.3	7,594.7	6,341.9	8,730.7	
Acq. O&M	2020	0	0	0	0	0	
Total		77,740.7	77,740.7		71,123.4	95,838.5	
PAUC	2020	117.968	117.968	129.765	107.926	145.430	
APUC	2020	75.486	75.486	83.035	68.685	97.150	

Budget Note

Funding realigned to meet current program phasing requirements with artificial cost growth attributed to change in inflation indices. Updated cost position for FY 2029 and beyond is anticipated approximately 3rd Quarter FY 2023.

Total End Item Quantity

Quantity Category	Current APB Quantity	Current Estimate Quantity
Development	25	25
Procurement	634	634
O&M-Acquired	--	--

Quantity Note

Quantities are based on Air Vehicle Equipment (AVE), which consists of a Booster, Guidance, Post-Boost, and Reentry System.

Unit Cost

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Current UCR Baseline and Current Estimate (Base-Year Dollars)			
Category ($M) Base Year: 2020	**Current UCR Baseline**	**Current Estimate**	**% Change**
Program Acquisition Unit Cost			
Cost	77,740.7	71,123.4	
Quantity	659	659	
Unit Cost	117.968	107.926	-8.51%
Average Procurement Unit Cost			
Cost	47,858.4	43,546.4	
Quantity	634	634	
Unit Cost	75.486	68.685	-9.01%

Original UCR Baseline and Current Estimate (Base-Year Dollars)			
Category ($M) Base Year: 2020	**Original UCR Baseline**	**Current Estimate**	**% Change**
Program Acquisition Unit Cost			
Cost	77,740.7	71,123.4	
Quantity	659	659	
Unit Cost	117.968	107.926	-8.51%
Average Procurement Unit Cost			
Cost	47,858.1	43,546.4	
Quantity	634	634	
Unit Cost	75.486	68.685	-9.01%

Risks

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Risk and Sensitivity Analysis

Risk and Sensitivity Analysis
Current Procurement Cost (December - 2022)
1. The program office estimate is composed primarily of parametric and analogous methodologies. The program office is closely monitoring monthly Earned Value submissions and other contractor data with the intent to inform the cost / schedule risk assessments. In addition to Original Baseline Estimate risks and sensitivities, the program office is monitoring and analyzing impacts to the cost of key inputs to include Aerospace Vehicle Equipment (AVE) components, operational ground deployment & construction (i.e., LFs, Launch Centers, utility corridor, and support facilities), and software. AVE is closely monitored as the Sentinel (GBSD) AVE subsystem composes more than 50% of the acquisition cost. Cost adjustments to AVE have potentially significant cost impacts. Operational ground deployment and construction contains many variables to include: National Environmental Policy Act (NEPA), LF deployment rates, requirement maturity, utility corridor and real estate acquisition. All these variables have significant impacts on cost and schedule in the Production and Deployment Phase of the program. Requirement refinement in utility corridor and real estate acquisition are ongoing and will be updated in future Program Office Estimates. COVID-19 is a cost impact that has not been completely considered as evidence of raw material costs remain above pre-COVID levels. Software includes traditional code development activities and Nuclear Safety Cross Check Analysis. The size, integration, and independent review of the software creates significant cost and schedule challenges. The program office estimate incorporates the detailed analysis of the integrated software oversight team in developing the cost / schedule risk assessment for each Computer Software Configuration Item (CI).
Original Baseline Estimate (September - 2018)
1. In preparing the GBSD Program Office Estimate, risk and uncertainty were assessed on the significant cost inputs (e.g., software, complex strategy, industry labor rates, etc.) into the model. The program office analyzed the distribution shape and developed minimum and maximum values using historical data and subject matter experts. The program model used a risk simulation as recommended by the Joint Agency Cost Schedule Risk and Uncertainty Handbook (CSRUH). Estimates were presented at the mean, which included approximately $1.3B in the EMD phase, $2.8B in the production phase, and $0.5B for MILCON risk and uncertainty. In preparing the Independent Cost Estimate (ICE) for GBSD Milestone B Review, OSD reviewed and included additional resources, citing the following reasons: ICBM industrial base, design/build concurrency, software, environmental, MBSE/Agile/DevSecOps, and contracting strategy.
Current Baseline Estimate (September - 2020)
1. There are no known risks for this baseline estimate.

Risk and Sensitivity Analysis

Significant Schedule Risks
Current Estimate (December - 2022)
Details of Schedule Risks of this program are Controlled Unclassified Information (CUI) and have been removed per paragraph (i) of title 10 United States Code 4351 which required the SAR be submitted without any designation relation to dissemination control.

Technologies and Systems Engineering

Significant Technical Risks
Current Estimate (December - 2022)
1. There are no known risks with this program at this time.

Low Rate Initial Production

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Item	Initial LRIP Decision	Current Total LRIP
Approval Date	09/04/2020	09/04/2020
Approved Quantity	211	211
Reference	Milestone B ADM	Milestone B ADM
Start Year	2026	2026
End Year	2029	2029

Rationale if quantity exceeds 10% of the total number of articles to be procured:

The four LRIP lots will include the equipment and labor needed to deploy, transport, operate, maintain, train, and sustain the Sentinel (GBSD) Weapon System (i.e., spares, training, installation, transportation, support equipment, etc.).

Contracts & Efforts

Contract Data	
Contract Number	FA8219-20-C-0006
Effort Number	
Modification Number	P00001
Award Date	09/08/2020
Definitization Date	09/08/2020
Order Number	
CAGE Code/CAGE Legal Name	8MQW5/Northrop Grumman Systems Corporation
Contract Title	GBSD EMD & Early Production and Deployment
Contract Address	Roy, UT
Contracting Office	
Supported Phase	Development
Contract Strategy	
Contract Type	Multiple Types
Modification Date	September 08, 2020
Work Start Date	September 08, 2020
Technical Data Rights	
Work Completed	25.68%

Contracts/Effort Price, Quantity, and Performance (TY$M)		
Initial Target Price	Current Target Price	
$13,293.6	$13,316.8	
Initial Ceiling Price	Current Ceiling Price	
N/A	N/A	
Contractor EAC	PM EAC	
$12,759.1	$13,735.1	
Initial Quantity	Current Quantity	Delivered Quantity
N/A	N/A	N/A
BAC	BCWP	ACWP
$11,689.2	$3,001.4	$3,286.8

BCWS	Cost Variance	Schedule Variance
$3,332.3	-$285.4	-$330.9

Contract Note:

PM's Estimate at Completion (EAC) does not include overhead and fee.

Factors Contributing to Cost Variance:
The unfavorable cost variance indicates that work accomplished is costing more than planned. Northrop Grumman is exploring improving forecasting. Sentinel program is within CAPE ICE.

Factors Contributing to Schedule Variance:
The unfavorable schedule variance Sentinel is experiencing due to macroeconomics factors affecting the industrial base because of COVID-19. Volatility in the supply chain is causing increasing lead times for parts and components that are extending to commodities. These pressures eliminated margin or pushed forecasted major program events dates past their baseline.

Deliveries and Expenditures

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Deliveries				
Delivered to Date	Planned to Date	Actual to Date	Total Quantity	Percent Delivered
Development	25	0	25	0.00%
Production	634	0	634	0.00%
Total Program Quantity Delivered	659	0	659	0.00%

Expended and Appropriated (TY $M)

Years Appropriated to date: 8

Total Years Appropriated Funding (Current Baseline): 26

Percent Years Appropriated: 30.77%

Then-Year Funding Appropriated as Percentage of Total Acquisition Estimate: 9.37%

Then-Year Funding Expended as Percentage of Total Acquisition Estimate: 6.09%

Total Acquisition Cost: $95,838.5

Deliveries and Expenditures Note

Expenditures are tracking to OSD goals.

Operating and Support Costs

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O&S Cost Breakdown:

Category (BY2020$ Million)	GBSD
Unit-Level Manpower	This Data has been marked as CUI and has been removed
Unit Operations	
Maintenance	
Sustaining Support	
Continued System Improvements	
Other	
Total	

Cost Estimate Source: ICE dated August 22, 2020
O&S Cost Note: The current estimate shown is based upon Milestone B ICE.

Total Program O&S Cost Compared with Baseline					
	Current Baseline				
Base Year: 2020	Objective (BY$M)	Threshold (BY$M)	Current Estimate (BY$M)	Current Estimate (TY$M)	Deviation
Total O&S	This Data has been marked as CUI and has been Removed	This Data has been marked as CUI and has been removed	This Data has been marked as CUI and has been removed	This Data has been marked as CUI and has been removed	This Data has been marked as CUI and has been removed

O&S Cost Deviation Explanation

This Data has been marked as CUI and has been removed

Operating and Support Costs - Disposal and Unitized Costs

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Annual Unitized O&S Cost Definition and Calculation Relative to Total O&S Cost:

LGM-35A Sentinel does not have MMIII O&S data. This will need to come from the Minuteman program office

Sustainment Factors	System Name: GBSD	Antecedent System Name: Minuteman III
Quantity to Sustain	634	473
Unit of Measure	Missiles	Missiles
Unit Expected Service Life	47	59

Base Year: 2020

Annual Unitized O&S Cost by Category Base Year $ Unit:($M)	System Name: GBSD	Antecedent System Name: Minuteman III
Unit-Level Manpower	This Data has been marked as CUI and has been Removed	$1.0
Unit Operations		$0.1
Maintenance		$0.8
Sustaining Support		$0.1
Continued System Improvements		$0.7
Other		$0.1
Total O&S		$2.7

Disposal/Demilitarization Cost Estimate

(BY2020$M)	System Name: GBSD	Antecedent System Name: Minuteman III
Total Disposal	This Data has been marked as CUI and has been Removed	

Cost Estimate Source - Disposal	
Type:	Independent Cost Estimate
Approval Authority and Date:	Richard P. Burke, Deputy Director, Cost Assessment 08/22/2020
Note:	
None	
Disposal Cost Notes:	
None	
Antecedent Estimate Assumptions:	
Quantity based on number of available booster set currently utilized average, annual AFTOC cost data from FY 2000- FY 2022.	