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Report to Congressional Requesters

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NATIONAL MISSILE DEFENSE

Schedule and Technical Risks Represent Significant Development Challenges

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GAO

United States
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National Security and
International Affairs Division

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December 12, 1997

The Honorable Carl Levin
Ranking Minority Member
Committee on Armed Services
United States Senate

The Honorable Jeff Bingaman
Ranking Minority Member
Subcommittee on Strategic Forces
Committee on Armed Services
United States Senate

In response to your request, we are providing an initial assessment of the technical and schedule risks associated with the National Missile Defense (NMD) program. The Department of Defense (DOD) has indicated that it intends to ask for $2.3 billion more for this program but has not released final plans showing how it intends to use the additional funds. The information provided in this letter is necessarily limited to the NMD acquisition strategy formally defined and approved by DOD as of September 19, 1997. Although changes are expected when final plans are released, the information in this letter should be a useful point of reference from which to analyze those new plans. We will continue to obtain information on these risks and other issues you asked us to examine.

Background

While the Ballistic Missile Defense Organization (BMDO) had been developing and maturing technologies for use in an NMD system for a number of years, in October 1996 it began developing a specific NMD system to provide protection against limited ballistic missile attacks targeted at the United States. Its mission is to detect, identify, engage, intercept, and destroy threatening ballistic missiles prior to their impact on any of the 50 states. The program focuses on the development of a system that could support a deployment readiness review in fiscal year 2000. The review would determine whether the initial system has been adequately demonstrated and if the existing threat justifies deployment of an initial capability by fiscal year 2003. This plan is commonly referred to as the “3+3” program. Figure 1 shows the program schedule, assuming a decision in fiscal year 2000 to deploy the system.

Figure 1: NMD Program Schedule

Task name	1996	1997	1998	1999	2000	2001	2002	2003	2004
Start date for the development of the 3+3 Program	◆								
Prime Contract Award			◆						
Integrated System Test				◆					
Deployment Readiness Review (system deployment decision)					◆				
Initial Operational Capability								◆	

While DOD is still determining the specific design of the initial NMD system, its features will include (1) space-based and ground-based sensors to provide early warning of attacking missiles; (2) ground-based radars to identify and track the threatening warheads; (3) ground-based interceptors to collide with and destroy incoming warheads; and (4) a battle management, command, control, and communications system. The NMD system architecture would evolve over time through incorporation of advanced element technologies to defend against more sophisticated threats. For example, the Space and Missile Tracking System, a space-based sensor constellation of infrared tracking and discrimination satellites providing early-trajectory capabilities, will be added to the system at a later time.

Results in Brief

DOD faces significant challenges in the NMD program because of high schedule and technical risks. Schedule risk is high because the schedule requires a large number of activities to be completed in a relatively short amount of time. The sequential nature of key development activities—such as not being able to proceed in earnest until a prime NMD contractor is selected in the spring of 1998—magnifies time pressures. Furthermore, developing and deploying an NMD system in the 6 years allotted under the 3+3 program will be a significant challenge for DOD given its past history with other weapon systems. For example, NMD's acquisition schedule is about one-half as long as that of the only other U.S.-based ballistic missile defense system. DOD acknowledges the high schedule risk.

Technical risks are high because the compressed development schedule only allows limited testing. The NMD acquisition strategy calls for conducting (1) one system test prior to the initial system deployment decision—a test that would not include all system elements or involve stressing conditions such as threats employing sophisticated countermeasures or multiple warheads—and (2) one test of the integrated ground-based interceptor before production of the interceptor's booster element must begin. If subsequent tests reveal problems, costly redesign or modification of already produced hardware may be required.

Compressed NMD Schedule Presents Challenges

Under the formally defined acquisition strategy, a large number of activities need to be completed in a relatively short time frame, and recent slips in program events have increased the program's schedule risk. DOD and BMDO officials have acknowledged the high schedule risk. According to testimony by the former Under Secretary of Defense for Acquisition and Technology, the program's schedule will remain high risk despite planned funding increases recommended by the recent Quadrennial Defense Review (QDR). DOD does not yet have a firm plan for how the additional funds will be used. Developing the NMD system will present DOD with significant challenges. The NMD schedule is shorter than most other major system acquisition programs.

Many Activities Must Be Accomplished in Short Time Frame

Even though the NMD development program officially began in October 1996, many development activities cannot proceed in earnest until BMDO selects a firm to serve as the prime contractor for the system. This underlines the sequential nature of many planned development activities. BMDO does not expect to complete this selection process until the spring of 1998. Then, the final design process cannot begin until the selected prime contractor has time to examine and analyze the requirements and architectures. For example, one of the prime contractor's responsibilities will be to develop and procure one or more radars for the system. There are two radar candidates, and until the prime contractor has had time to examine them, analyze their performance in selected settings and architectures, and make a selection of one or more of the candidates, the radar procurement process cannot begin. Similarly, the acquisition of the booster for the ground-based interceptor cannot begin until the prime contractor has assessed the alternatives, which include developing a new booster, using an existing booster, or modifying an existing design to meet the NMD requirements.

Furthermore, a number of activities are dependent on the final system design. For example, after the design is determined, sites will have to be selected. DOD will have to obtain land, build or modify facilities, and conduct environmental impact studies. According to a preliminary analysis by the NMD system engineering contractor,[1] the ability to (1) construct and install radars and interceptor communication sites in the 3-year deployment window; (2) obtain easements, land, and rights-of-way for sites; and (3) conduct environmental impact studies by 2003 will present a significant challenge.

Recent Delays Have Increased Schedule Risk

Recent delays have increased schedule risk. Since the 3+3 program was approved, BMDO has experienced a 7-month delay in establishing the joint program office to manage the acquisition and a 6-month delay in awarding concept definition contracts leading to the selection of a prime contractor. Also, a sensor flight-test failure resulted in a 6-month testing delay.[2] According to the former Under Secretary of Defense for Acquisition and Technology, these slips have increased the schedule risk.

Schedule Risk Will Remain High Despite Funding Increases

DOD officials have acknowledged the high risk involved in the schedule. In order to help maintain the fiscal year 2003 deployment option, the Department's recent QDR recommended significant increases in program funding through fiscal year 2000. The QDR was commissioned to provide a comprehensive examination of the defense strategy, force structure, force modernization plans, infrastructure, budget plan, and other elements of

[1]The system engineering contractor is responsible for helping the NMD project office generate, verify, and validate requirements while the prime contractor will be responsible for designing, developing, integrating, and testing the NMD system.

[2]This test was rescheduled and flown in June 1997, and according to BMDO, the test was successful.

the defense program and policies. It considered three alternatives for dealing with the future of the NMD program. Two of the alternatives would have slipped the earliest possible schedule for system deployment to a date later than fiscal year 2003. The alternative selected in the QDR is predicated on adding an estimated $2.3 billion to the program in fiscal year 1998 through fiscal year 2003, while retaining the potential deployment of the system in fiscal year 2003. However, according to the former Under Secretary of Defense for Acquisition and Technology, the additional funding will not reduce the high schedule risk inherent in the program. DOD does not yet have a firm plan for how the additional funds will be used.

Acquisition Schedule Is Shorter Than Most Other Major Systems

The acquisition schedule is about one-half as long as the Safeguard's—the only other U.S.-based ballistic missile defense system.[3] The NMD schedule is also shorter than schedules projected for acquisition of most other U.S. missile defense programs. For example, the Theater High Altitude Area Defense program is currently projected to require 13 years to reach its first unit-equipped milestone. The Patriot PAC-3 system is projected to take 5 years from the beginning of engineering and manufacturing development to reach the first unit-equipped date, even though it is only a modification to an existing air defense system.

The NMD acquisition schedule is also shorter than the average time projected to acquire and field 59 other major weapon systems that we examined.[4] These are the programs for which DOD had Selected Acquisition Reports in December 1996. These systems are projected to take an average of just under 10 years from the beginning of their development until they reach an initial operating capability date. The estimated fielding times for the 59 programs ranged from 5 years to 19 years. (See app. I.)

[3]Development of Safeguard system components began in 1963 and the system's single site at Grand Forks, North Dakota, achieved full operational capability in 1975. The program was terminated in 1976.

[4]We reviewed all of the December 31, 1996, Selected Acquisition Reports for systems that contained both (1) an acquisition milestone I date (approval to begin developing a new system) or a milestone II date (approval to begin engineering and manufacturing development) and (2) an initial operating capability date. We measured the time estimated from either milestones I or II to the initial operating capability date for the 59 programs that met that criteria. The mean time between these milestones was 9.9 years. The median was 9.1 years.

Limited Testing Planned Before Possible Deployment Decision in Fiscal Year 2000

Because of the compressed development schedule, only a limited amount of flight test data will be available for the system deployment decision in fiscal year 2000. By that time, BMDO will have conducted only one system-level flight test, and that test may not include all system elements or involve stressing conditions such as targets that employ sophisticated countermeasures or multiple warheads. As a result, not all technical issues, such as discrimination,[5] will be resolved by the time of the deployment review. Also, the current schedule will permit only a single test of the integrated ground-based interceptor before production of the interceptor's booster element[6] must begin. If subsequent tests reveal problems, costly redesign or modification of already produced hardware may be required.

Few Flight Tests Prior to Deployment Decision

The current development schedule provides for only three flight intercept tests prior to the fiscal year 2000 deployment decision. Only one of these will be an integrated system test, and that test will not be comprehensive because it will not include all system elements. If the test fails, the deployment review would be left with only ground test data and partial-system flight data when considering the deployment option. This presents a high performance and schedule risk to the program. According to BMDO, the lack of back-up test hardware is a primary contributor to program risk. For example, this lack of a back-up target caused the 6-month delay in rescheduling the sensor flight test after the January 1997 test failure.

Additionally, the single integrated system test planned prior to the fiscal year 2000 deployment review will not assess the NMD system's capabilities against stressing threats such as those that use sophisticated countermeasures or multiple warheads. The test is to be conducted against a single target with only simple countermeasures such as decoys. No test against multiple warheads is planned.

The integrated system test, as currently planned, will not include all elements of the planned system. For example, the current plan is to use a payload launch vehicle rather than the actual ground-based interceptor booster because, according to NMD program officials, it will probably not

[5]Discrimination is the system's ability to distinguish between warheads and other, nonthreatening objects such as decoys and debris that may be present and detected by radars and other sensors.

[6]The ground-based interceptor will consist of a booster and an exo-atmospheric kill vehicle. The booster is to propel the kill vehicle to a point in space near the attacking warhead. The kill vehicle is to locate, identify, and collide with the attacking warhead.

be available in time for the test. A lack of flight test data on the booster before the deployment review could impact the credibility of the interceptor's performance evaluation as well as the overall system assessment. According to the NMD program's system engineering contractor, there is a high risk that the evaluation of the NMD capability will be incomplete or not representative of the true system capability. DOD acknowledged the testing limitations and they were highlighted in the program's own risk assessment.

Some Technical Issues Will Not Be Resolved in Tests

There are a number of technical concerns that will not be resolved by the time of the potential fiscal year 2000 deployment decision. For example, DOD still has not shown that the type of interceptors planned for the system—hit-to-kill interceptors—can provide a reliable defense under stressing conditions. To date, there have been very few tests of hit-to-kill interceptors and even fewer successful intercepts. Of the 20 intercept attempts since the early 1980s, only 6, or about 30 percent, have been successful. While these intercepts provide proof of the principle of hit-to-kill intercept, they do not demonstrate that the concept can be employed reliably or under stressing conditions.

Also, according to the system engineering contractor, the test program will not test system-level discrimination capabilities sufficiently to ensure that requirements can be met. The accurate discrimination of incoming threat objects from nonthreatening objects such as decoys and debris that may be present is vital to the system's ability to successfully defend the United States from an attack. Without discrimination, too many interceptors may be wasted on nonthreatening objects and attacking warheads could escape identification. To perform the discrimination task, data from a number of different types of sensors—both internal and external to the system—will have to be obtained, correlated, associated, or fused by the battle management, command, control, and communications system. According to the system engineering contractor, NMD system discrimination requirements will exceed previous experience and a number of concerns exist. These include concerns about the development and validation of algorithms for (1) optical and infrared sensor discrimination, (2) fusing data from sensors of different technologies, and (3) resolving any differences or ambiguities between radar and optical data.

Limited Number of Interceptor Tests Represents Risk

The tentative schedule for the ground-based interceptor shows that full-scale production would need to start by January 2000 to achieve an initial operating capability by 2003. To meet this schedule, DOD would have to award the contract for interceptor production after only one flight test of the combined booster and its designated kill vehicle. If subsequent tests reveal problems, the design may have to be revised and costly, time-consuming changes made.

Agency Comments

In commenting on a draft of this report, DOD concurred that the NMD program faces significant challenges because of high schedule and technical risk. It also stated that the report is generally accurate, but provided some clarifying comments on the program's status, comparison of certain flight tests, and impact of testing and test hardware on risk. DOD's comments and our evaluation are presented in appendix II. DOD also provided technical comments, which we incorporated as appropriate.

Scope and Methodology

To assess the NMD program's schedule and technical risks, we reviewed available program plans, test plans, milestone schedules, requirements documents, and management reports. To determine the level of risk and major factors contributing to it, we analyzed the program's status, strategy for accomplishing the remaining development work and meeting fielding requirements, and approaches to demonstrating the system's capabilities and military suitability. We also discussed schedule and technical risks and plans for mitigating them with officials at the Ballistic Missile Defense Office, Washington, D.C.; the Office of the Director, Operational Test and Evaluation, Alexandria, Virginia; and the Army NMD Project Office, Huntsville, Alabama. To provide a basis for comparison with the NMD program schedule, we obtained schedule data for 59 other major acquisition programs from DOD's Selected Acquisition Reports.

We conducted our work from September 1996 through September 1997 in accordance with generally accepted government auditing standards.

As agreed with your office, unless you publicly announce its contents earliler, we plan no further distribution of this report until 30 days from its issue date. At that time, we will send copies of this report to other interested congressional committees, the Secretary of Defense, and the Directors of the Ballistic Missile Defense Organization and the Office of Management and Budget. Copies will also be made available to others upon request.

If you or your staff have questions concerning this report, please contact me at (202) 512-4841. The major contributors to this report were Lee Edwards, Bobby Hall, and Tom Hopp.

Allen Li
Associate Director
Defense Acquisitions Issues

Time Required to Develop and Field Major Systems

System	Begin development	Initial operational capability	Elapsed time (years)
Program 1[a]	[b]	[a]	7
Joint Direct Attack Munition for F/A-18	Oct. 1993	Sept. 1999	6
Brilliant Anti-Tank	Feb. 1985	Nov. 1999	15
Army Tactical Missile System Block II	May 1995[b]	Mar. 2004	9
Program 3[a]	[c]	[a]	8
Longbow Apache-Airframe Modifications	Aug. 1985	Oct. 1998	13
Sense and Destroy Armor	Mar. 1988[b]	July 1999	11
Javelin	May 1986	Oct. 1996	10
Comanche Program	June 1988	July 2006	18
Program 4[a]	[c]	[a]	8
Program 5[a]	[b]	[a]	7
F-22	Oct. 1986	Nov. 2004	18
Advanced Medium Range Air-to-Air Missile	Nov. 1978	Sept. 1991	13
Navy EHF SATCOM Program	Jan. 1982[b]	Apr. 1994	12
DDG-51 Guided Missile Destroyer	June 1981	Feb. 1993	12
New SSN/New Attack Submarine	Aug. 1994	Oct. 2005	11
High Speed Nuclear Attack Submarine	Dec. 1983	May 1997	13
Trident II Missile	Oct. 1977	Mar. 1990	12
Airborne Warning and Control System Radar System Improvement	Dec. 1988[b]	Dec. 1999	11
Joint Stars	Sept. 1985[b]	Sept. 1997	12
Minuteman III Guidance Replacement Program	Aug. 1993	Jan. 2000	6
Minuteman III Propulsion Replacement Program	June 1994[b]	Jan. 2002	8
Program 7 [a]	[b]	[a]	11
Abrams Tank Upgrade	Feb. 1985[b]	Feb. 1993	8
Army Tactical Missile System-Antipersonnel/Antimateriel Warhead	Feb. 1986[b]	Aug. 1990	5
Longbow Hellfire	Aug. 1985	July 1998	13
Cooperative Engagement Capability	May 1995[b]	July 2000	5
Hawkeye (mission computer upgrade only)	Sept. 1994[b]	June 1999	5
LHD1 Amphibious Assault Ship	Oct. 1981	Nov. 1990	9
Program 8[a]	[c]	[a]	11
MIDS-LVT	Dec. 1993[b]	Apr. 2000	6
Multi-Mission Helicopter Upgrade (SH-60R)	July 1993[b]	Oct. 2002	9
Tomahawk Improvement Program (RGM-109)	Sept. 1994[b]	Aug. 2000	6
Marine Corps H-1 Upgrade Program	Oct. 1996[b]	June 2005	9
Jet Flight Training System	Sept. 1984	Apr. 1993	9
Strategic Sealift	Aug. 1992	Jan. 1998	5
Coastal Minehunter Ship (MHC-51)	June 1986	Sept. 1996	10

(continued)

System	Begin development	Initial operational capability	Elapsed time (years)
F/A-18E/F Naval Strike Fighter (Hornet)	May 1992[b]	Sept. 2000	8
Joint Services Advanced Vertical Lift Aircraft	Dec. 1982	July 2001	19
AOE6 Class Fast Combat Support Ship	July 1982	June 1995	13
Advanced Amphibious Assault Vehicle	Mar. 1995	June 2006	11
B-1B Mission Upgrade Program-Computer	Apr. 1993	Dec. 2001	9
Advanced Field Artillery Tactical Data System	May 1984	Jan. 1997	13
Crusader Field Artillery System	Nov. 1994	June 2006	12
Combat Service Support System Version 3	Dec. 1990	Oct. 1997	7
Forward Area Air Defense Command, Control, and Intelligence	July 1986[b]	Sept. 1994	8
Family of Medium Tactical Vehicles	May 1987	Jan. 1996	9
Airborne Laser	Nov. 1996	Sept. 2006	10
Milstar Satellite	June 1983	June 1997	14
Joint Service Imagery Processing System	July 1986	Dec. 1994	8
Bradley Fighting Vehicle Upgrade	Jan. 1994	Aug. 2000	7
Single Channel Ground and Airborne Radio System	Feb. 1976	Dec. 1990	15
C-17 Globemaster III	Feb. 1985[b]	Jan. 1995	10
Joint Primary Aircraft Training System	Jan. 1993	Aug. 2001	9
Program 9[a]	[b]	[a]	8
Program 10[a]	[b]	[a]	11
All Source Analysis System	Sept. 1993[b]	Dec. 1999	6
B-1 Conventional Mission Upgrade Program—Joint Direct Attack Munition	Apr. 1993	Dec. 1998	6
National Airspace System—Air Traffic Control	July 1992	Apr. 2000	8
Average			**9.9**

[a]Initial operational capability dates for these systems are classified. To avoid classification, system name and milestone dates are not shown.

[b]Date reflects beginning of milestone II (approval to enter engineering and manufacturing development) because these systems began in that phase.

[c]Date reflects beginning of milestone I (approval to begin development of a new program) because these systems began in that phase.

Source: DOD Selected Acquisition Reports, December 31, 1996.

Comments From the Department of Defense

Note: GAO comments supplementing those in the report text appear at the end of this appendix.

ACQUISITION AND TECHNOLOGY

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14 NOV 1997

Mr. Allen Li
Associate Director, Defense Acquisitions Issues
National Security and International Affairs Division
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Dear Mr. Li:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report, "NATIONAL MISSILE DEFENSE: Schedule and Technical Risks Represent Significant Development Challenges," dated October 15, 1997, (GAO Code 707208), OSD Case 1477.

The Department generally concurs that the National Missile Defense (NMD) program faces significant challenges because of high schedule and technical risks. The report is generally accurate; however, the Department feels some sections contain errors which are addressed in the attached enclosure.

The Department appreciates the opportunity to comment on the draft report.

Sincerely,

George R. Schneiter
Director
Strategic and Tactical Systems

Enclosure

"NATIONAL MISSILE DEFENSE: Schedule and Technical Risks Represent Significant Development Challenges," dated October 15, 1997, (GAO Code 707208), OSD Case 1477

DEPARTMENT OF DEFENSE COMMENTS

Key Issues

See comment 1.

1. The report does not acknowledge any of the successes the program has had recently and appears to include somewhat outdated material. For example, no mention is made of the successful flight test of an Exoatmospheric Kill Vehicle (EKV) sensor against a threat representative target suite earlier this year. It makes no mention of the successful participation in that test of BM/C3 and early warning systems. It also fails to acknowledge that the structural facilities for the prototype Ground-based Radar (GBR) were completed just 1 year after ground breaking and that the prototype GBR is on track to be operational by the end of 1998. It provides no current status to indicate that the rest of the program is on track to support the upcoming ground and flight tests prior to the Deployment Readiness Review (DRR). The report implies that the program was initiated in October 1996 and that no prior related work had been accomplished. In fact, the current Deployment Readiness Program (DRP) was a natural evolution of the Ballistic Missile Defense Organization (BMDO) Technology Readiness Program (and even efforts prior to that) in which many of the critical technologies were investigated, lead times were defined and shortened where possible, and in which most of the element design efforts were completed.

See comment 2.

2. The report implies that there are new risks from the limited flight testing. The limited number of flight tests before the DRR was known when the program transitioned to Major Defense Acquisition Program status and has not changed. It was also known at that time that the edges of the National Missile Defense (NMD) performance envelope would not be tested (or even testable) in flight, due to range safety and other considerations--that is, that simulations and hardware-in-the-loop would be critical to demonstrating NMD system performance. No mention is made of the robust ground test program that has long been underway.

See comment 3.

3. The comparison in calculating the number of the flight tests completed for SAFEGUARD versus NMD is an apples-to-oranges comparison. The start and stop points are not consistent in measuring the two programs. For SAFEGUARD, the number of tests are calculated from start until operational, whereas for NMD the only tests counted are the ones prior to the DRR. Additionally, only tests utilizing dedicated NMD targets and NMD Interceptor components are counted, not the target of opportunity

See comment 4.

tests and ground-based tests involving other components of the NMD system. The test program continues after 2000 with at least 3 dedicated Ground-based Interceptor (GBI) flights per year which the GAO has not counted in their comparison. When a decision is made to deploy the system, the system level testing will increase to 4 flights per year.

4. The report ignores the lack of back-up test hardware as a primary contributor to program risk even though LTG Lyles testified on this to Congress in May 1997. The example that he used was that the lack of a back-up target after the January 1997 EKV sensor flight test attempt caused a 6-month delay in accomplishment of that test. Additionally, the lack of spares was a consideration in the QDR recommendation to increase funding for the NMD program. This factor seems to be the most serious recurring threat to accomplishing the goals of the first 3 years of development. It is not so much that the schedule is compressed as it is that there is not much of contingency capability to respond to failures in the flight test program because of the lack of hardware--once a problem occurs, there is no way to recover, other than to slip the schedule.

DoD Comments on GAO Draft Report 707208, dtd Oct 97

The following are GAO's comments on DOD's letter dated November 14, 1997.

GAO Comments

1. As requested, we focused on the program's schedule and technical risk. However, we revised the text to show that a lengthy period of technology development preceded the specific program's initiation in October 1996 and that successful testing has occurred. Even though DOD has built structural facilities for the prototype radar and is on track to meet established ground and flight tests, the program's schedule and technical risks remain high, as DOD itself acknowledges.

2. We do not state that the risk from limited flight testing was not known when the program was initiated or that officials did not know at that time that the flight tests would be constrained by range safety and other considerations. Even though known, the test limitations significantly increase the level of technical risk. We clarified the text to show that DOD acknowledges these limitations and that they were highlighted in the program's own risk assessment.

3. We agree that the testing programs are not directly comparable and revised the text to delete the comparison. The point we were making is that because of the constrained schedule, the amount of flight testing is less than would normally be expected. This point remains valid.

4. We added information to show that the lack of back-up hardware contributes to program risk and that the lack of a back-up target caused the 6-month delay in rescheduling the sensor flight test.

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