OFFICE OF THE DIRECTOR OF
DEFENSE RESEARCH AND ENGINEERING
3040 DEFENSE PENTAGON
WASHINGTON, D.C. 20301-3040

JUL 12 2001

MEMORANDUM FOR ODUSD(S&T) DIRECTORS

SUBJECT: Interim Guidance for Implementing Technology Readiness Levels

The new June 10, 2001 updated Department of Defense Regulation 5000.2R, Mandatory Procedures for Major Defense Acquisition Programs (MDAPs) and Major Automated Information System (MAIS) Acquisition Programs reflects the Science and Technology (S&T) role in the acquisition process. The S&T community must be actively engaged in enabling the rapid transition of mature technologies to product developers and actively participate in acquisition system integrated product teams. The regulation requires that the Component Science and Technology Executives conduct a technology readiness level (TRL) assessment (or some equivalent assessment) for critical technologies identified in ACAT ID and ACAT IAM programs prior to Milestone B and C. In cooperation with the Component S&T Executive and program office, the DUSD (S&T) must evaluate this assessment (including the Technology Readiness Level for each critical technology) and forward a concurrence with these findings to the Overarching Integrated Product Team Leader and the Defense Acquisition Board. It should be noted that TRL assessments are the preferred approach for all new programs unless DUSD (S&T) approves an equivalent assessment method.

The DSTAG recommended that a TRL IPT be established to define the guidelines and framework for implementing and applying TRLs in a consistent manner throughout the Department. The IPT developed guidelines for the S&T community to use in implementing TRL during the process. The attached interim guidelines include:

- Technology Readiness Assessment Process (Attachment 1)
- Definitions of Technology Readiness Levels (Attacment 2)
- Elements for a Technology Readiness Agreements including a sample (not mandatory) (Attachment 3)

Your active leadership and participation in your technical area plays a significant role in the implementation of TRLs across the Department. As shown in the TRL Process chart, we will be required to validate TRL assessments conducted by the Component S&T Executives. Attachment 4 is an example of a format that can be used in reviewing the TRL assessment of an acquisition

program. Note that our review needs to be signed by both the technical action offices and his/her director. As a recognized partner in the acquisition process, we must insert ourselves much earlier in the process. I personally encourage each of you and your staffs to be actively involved during the identification of critical technologies process and in the Working Integrated Product Teams (WIPTs) for ACAT ID and ACAT IAM programs.

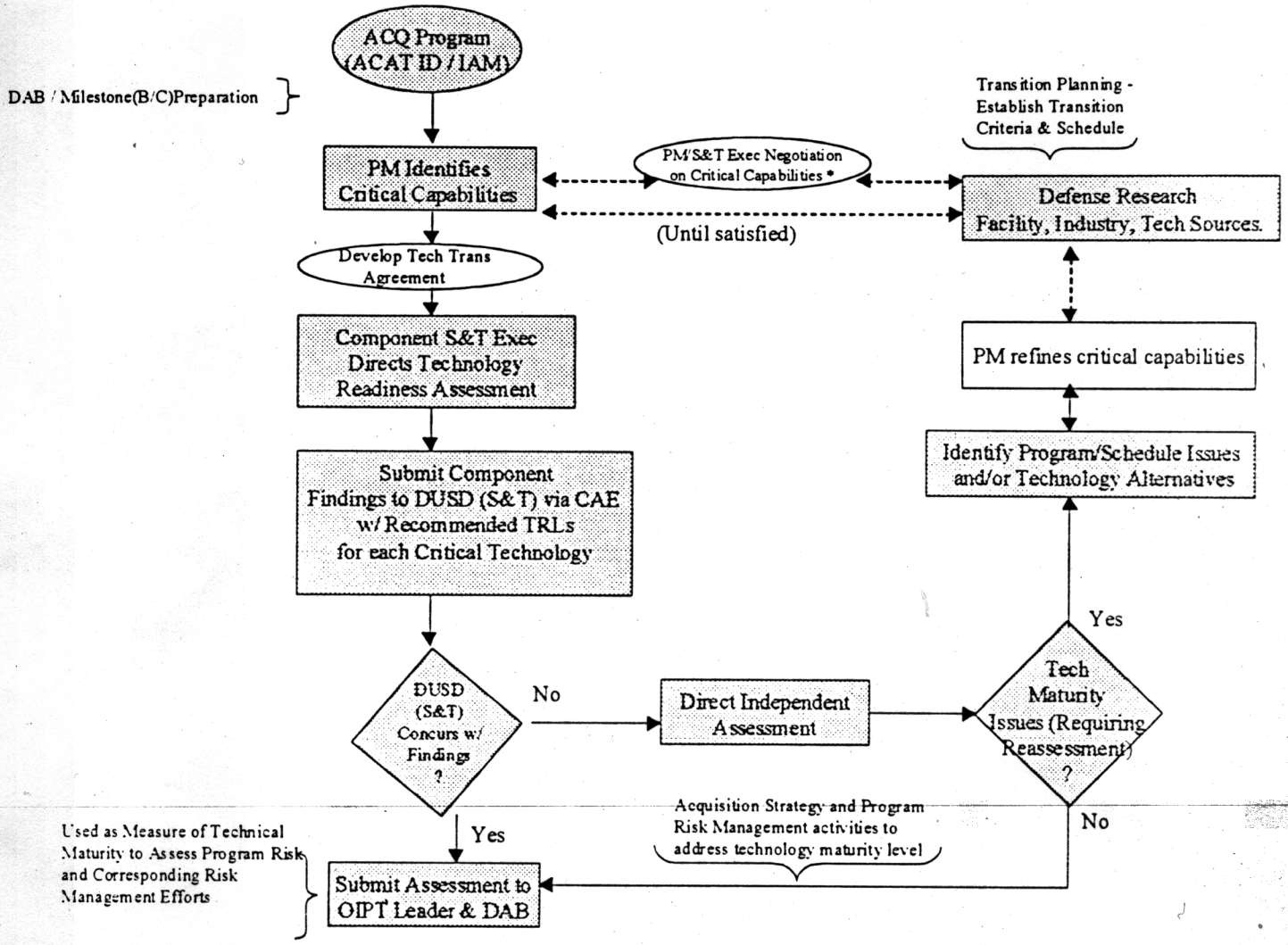
The S&T Plans and Programs office is responsible for maintaining a list of all ACAT ID AND acat iam programs requiring technology assessments and maintaining a copy of DUSD(S&T)'S review of TRL assessments. If you have any questions or comments, please contact Mr. Al Shaffer, Director, S&T Plans and Programs at (703) 695-9604.

Delores M. Etter

Delores M. Etter
Deputy Under Secretary of Defense
(Science and Technology)

Attachments:
As stated.

TECHNOLOGY READINESS ASSESSMENT PROCESS



* NO NEGOTIATION ON TRL ASSESSMENT

Attachment 1

DEFINITIONS OF TECHNOLOGY READINESS LEVEL

The following table lists the various technology readiness levels and descriptions from a systems approach for both HARDWARE and SOFTWARE.(Components may provide additional clarifications for Software)

Technology Readiness Level	Description
1. Basic principles observed and reported.	Lowest Level of Technology Readiness. Scientific research begins to be translated into applied research and development. Examples might include paper studies of a technology's basic properties.
2. Technology concept and/or application formulated.	Invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative and there is no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies.
3. Analytical and experimental critical functions and/or characteristic proof of concept.	Active research and development is initiated. This includes analytical studies and laboratory studies to physically validate analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.
4. Component and/or breadboard validation in laboratory environment.	Basic technological components are integrated to establish that they will work together. This is relatively "low fidelity" compared to the eventual system. Examples include integration of "ad hoc" hardware in the laboratory.
5. Component and/or breadboard validation in relevant environment.	Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so that it can be tested in a simulated environment. Examples include "high fidelity" laboratory integration of components.
6. System/subsystem model or prototype demonstration in a relevant environment.	Representative model or prototype system, which is well beyond that of TRL 5, is tested in a relevant environment. Represents a major step up in technology's demonstrated readiness. Examples include testing a prototype in a high fidelity laboratory environment, or in a simulated operational environment.
7. System prototype demonstration in an operational environment.	Prototype near, or at, planned operational system. Represents a major step up from TRL 6, requiring demonstration of an actual system prototype in an operational environment, such as an aircraft, vehicle, or space. Examples include testing the prototype in a test bed aircraft.
8. Actual system completed and "flight qualified" through test and demonstration.	Technology has been proven to work in its final form and under expected conditions. In almost all cases, TRL represents the end of true system development. Examples include developmental test and evaluation of the system in its intended weapon system to determine if it meets design specifications.
9. Actual system "flight proven" though successful mission operations.	Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation. In almost all cases, this is the end of the last "bug fixing" aspects of system development. Examples include using the system under operational mission conditions.

DEFINITIONS:

BREADBOARD: Integrated components that provide a representation of a system/subsystem and which can be used to determine concept feasibility and to develop technical data. Typically configured for laboratory use to demonstrate the technical principles of immediate interest. May resemble final system/subsystem in function only.

"HIGH FIDELITY": Addresses form, fit and function. High fidelity laboratory environment would involve testing with equipment that can simulate and validate all system specifications within a laboratory setting.

"LOW FIDELITY": A representative of the component or system that has limited ability to provide anything but first order information about the end product. Low fidelity assessments are used to provide trend analysis.

MODEL: A reduced scale, functional form of a system, near or at operational specification. Models will be sufficiently hardened to allow demonstration of the technical and operational capabilities required of the final system.

OPERATIONAL ENVIRONMENT: Environment that addresses all of the operational requirements and specifications required of the final system to include platform/packaging.

PROTOTYPE: The first early representation of the system which offers the expected functionality and performance expected of the final implementation. Prototypes will be sufficiently hardened to allow demonstration of the technical and operational capabilities required of the final system.

RELEVANT ENVIRONMENT: Testing environment that simulates the key aspects of the operational environment.

SIMULATED OPERATIONAL ENVIRONMENTAL: Environment that can simulate all of the operational requirements and specifications required of the final system or a simulated environment that allows for testing of a virtual prototype to determine whether it meets the operational requirements and specifications of the final system.

ELEMENTS OF TECHNOLOGY TRANSITION AGREEMENT

The following elements should be considered for inclusion in a technology agreement between an acquisition program, the intended receiver of a technology or capability development, and a science and technology activity, the developer and provider of the technology. Not every one of these elements is appropriate for every agreement, but each agreement should have considered these for inclusion.

Agreements, to be effective, must be reviewed periodically with both S&T management and program office management representatives participating. These reviews should address technical progress and future directions.

Elements to be provided by the Program Office:

a. **Target Acquisition Program.** A brief description of the acquisition program intended to receive the technology that is to be transitioned. Include major program objectives, current phase of acquisition life cycle, and projected initial operational capability date.

b. **Program Manager/Project Officer.** Program manager and individual in program office responsible for day-to-day management with contact information.

c. **Acquisition Program Technology Need.** Brief description of the benefit that this technology will bring to the acquisition program, or need satisfied. Where possible, relate benefit to ORD, KPP, etc. Include need dates for specific capabilities.

d. **Integration Strategy.** Describe the process for integrating the technology into the acquisition program. Include elements of acquisition strategy – evolutionary acquisition, block upgrade, etc., as well as required contractor to contractor agreements

Elements to be provided by S&T Activity

a. **Description of Technology or Capability to be Delivered.** Brief description of what the S&T activity intends to develop for transition to the acquisition program. Include capability delivery dates.

b. **Technology Manager.** Individual designated by the S&T activity to be the coordinator and day-to-day manager of the development of the needed technology.

c. **Current Status of Technology.**

1. **Status Summary.** Summarize current state of development. Identify primary areas where additional development is required. Provide estimate of current TRL.

2. **Risk Analysis.** Major areas of risk, prioritized, with planned mitigation activities. Include technical (e.g., producibility, affordability, sustainability) cost, and schedule risks.

d. **Technology Development Strategy**. Outline approach planned. Efforts required beyond those currently underway; integration plans if multiple projects are planned. Planned ATD or ACTD developments, if applicable

e. **Key Technical Measures of Readiness to Transition**. Identify the key parameters or attributes that will be used to measure whether or not the technology development effort is proceeding appropriately. Include parameter to be tracked, current state, interim progress estimates, and final objective. Technology Readiness Levels are a measure of technical maturity and can be used to assess readiness to transition.

f. **Program Plan.** Show major activities/efforts comprised by the technology development activity with milestones.

Signatures. Technology transition agreements should be signed as required to commit the participating organizations to the plan outlined in the agreement. The program manager(s) of the acquisition program(s) involved and the S&T project manager, should sign.

- SAMPLE -

TECHNOLOGY TRANSITION AGREEMENT

Basic Transition Agreement

1. **Description of Technology or Capability to be Delivered.**

2. **Target Acquisition Program.**

3. **Acquisition Program Technology Need**

4. **Integration Strategy**

5. **Program Manager/Project Officer**

6. **Technology Manager**

Technical Details and Programmatics

1. **Technology – Current Status**

   a. **Summary – Status**

   b. **Risk Analysis**

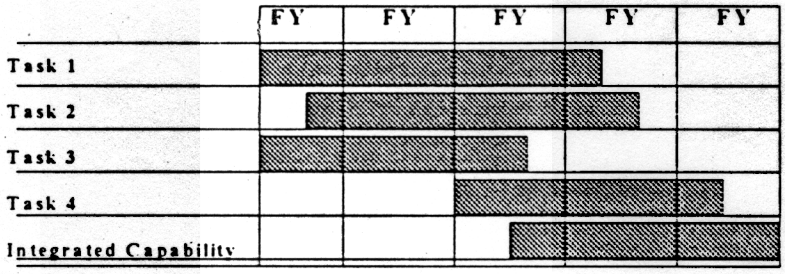
Top Risks	Brief Description	Mitigation Strategy

2. **Technology Development Strategy.**

3. **Key Measures of Transition Readiness**

Attribute/Parameter	Current	Interim (w/Est Date)	Final Objective

4. **Program Plan**



SIGNATURES:

Acquisition PM

S&T Project Manager

ODUSD (S&T)/WS UH-60M Program
Technology Readiness Level Assessment

The UH-60M Program TRL assessment is grouped into three categories. They are Cockpit Digitization, Propulsion, and Airframe. These categories are subdivided into 16 individual TRL assessments. Source information for this appraisal includes direct knowledge of specific supporting science and technology (S&T) activities, documentation provided by the SAALT staff, and information derived from the DOT&E website on Black Hawk modernization at http://www.dote.osd.mil/reports/FY00/army/00blackhawkuh60.html.

Category 1 - Cockpit Digitization

Element 1 - Stormscope

- Army Assessment: 8 DUSD (S&T) Assessment: Concur
- Supporting Rationale: Commercial-off-the-Shelf (COTS) item, already fielded on the UH-60Q and HH-60L

Element 2 - Dual Embedded GPS Inertial (EGI) Navigation System

- Army Assessment: 7 DUSD (S&T) Assessment: Concur
- Supporting Rationale: EGI has flown on CH-47 and MH-60K. Apache Program is currently demonstrating/qualifying an updated version.

Element 3 - Cockpit Voice Recorder (CVR)/Flight Data Recorder (FDR)

- Army Assessment: 7 DUSD (S&T) Assessment: Concur
- Supporting Rationale: COTS component. Technology demonstrated on the MH-60K Program and civil aviation aircraft. Qualification efforts ongoing for MH-60K and MH-47E fleets.

Element 4 - Advanced Flight Control Computer (AFCC)

- Army Assessment: 7 DUSD (S&T) Assessment: Concur
- Supporting Rationale: Based upon SH-60 and S-92 architecture. Qualification testing is ongoing.

Element 5 - Improved Data Modem (IDM)

- Army Assessment: 7 DUSD (S&T) Assessment: Concur
- Supporting Rationale: IDM currently in use on OH-58D and AH-64 platforms.

Category 2 - Propulsion

Element 1 - Crashworthy External Fuel System (CEFS)

- Army Assessment: 7 DUSD (S&T) Assessment: Concur
- Supporting Rationale: Product of a Cooperative Research and Development Agreement intended to improve the crashworthiness and reduce the ballistic vulnerability of the existing Extended Range Fuel System (ERFS). Airworthiness Qualification Testing ongoing.

ODUSD (S&T)/WS UH-60M Program
Technology Readiness Level Assessment (cont'd)

Category 2 – Propulsion (cont'd)

Element 2 - Wide Chord Blade (WCB)
- Army Assessment: 7 DUSD (S&T) Assessment: Concur
- Supporting Rationale: DoD Dual Use Application Program COSSI effort to qualify a commercially developed main rotor blade for use in the military environment. Airworthiness Qualification Testing ongoing.

Element 3 - T700-GE-701C Engine
- Army Assessment: 9 DUSD (S&T) Assessment: Concur
- Supporting Rationale: Currently fielded on the UH-60L with over 400 A/C, 2 engines per A/C

Element 4 - Improved Durability Gearbox (IDGB), Rotorhead & Control
- Army Assessment: 9 DUSD (S&T) Assessment: Concur
- Supporting Rationale: Currently fielded on the UH-60L with over 400 A/C

Element 5 - Improved Infrared (IR) Suppressor
- Army Assessment: 7 DUSD (S&T) Assessment: Concur
- Supporting Rationale: Discrete Design Modifications to HIRSS currently installed on the UH-60 fleet. System flight demonstrations completed with no significant issues noted.

Category 3 - Airframe

Element 1 - Refurbishment
- Army Assessment: 9 DUSD (S&T) Assessment: Concur
- Supporting Rationale: No new technologies or materials being used in refurbishment efforts.

Element 2 - Standardization
- Army Assessment: 9 DUSD (S&T) Assessment: Concur
- Supporting Rationale: Using existing Maintenance Work Orders for the current version of the UH-60L aircraft.

Element 3 - Tailcone & Stabilator
- Army Assessment: 9 DUSD (S&T) Assessment: Concur
- Supporting Rationale: Being accomplished already on the UH-60A/L aircraft.

Element 4 - Transition Access Door
- Army Assessment: 9 DUSD (S&T) Assessment: Concur
- Supporting Rationale: Same modification being accomplished on the UH-60Q.

ODUSD (S&T)/WS UH-60M Program
Technology Readiness Level Assessment (cont'd)

Category 3 – Airframe (cont'd)

Element 5 - Electro Magnetic Interference (EMI) Wiring
- Army Assessment: 9 DUSD (S&T) Assessment: Concur
- Supporting Rationale: No new technologies or materials required. Material solution for the UH-60M is currently fielded wiring or that used on MH-60K.

Element 6 - External Stores Support System (ESSS)
- Army Assessment: 9 DUSD (S&T) Assessment: Concur
- Supporting Rationale: No new technologies required. Currently fielded on the UH-60L.

Action Officer: >>Signed<< Date:_____
Paul F. Piscopo, Staff Specialist for Aircraft Systems

Director: >>Signed<< Date:_____
George Ullrich, Director, Weapons Systems Directorate

Prepared by: Mr. Paul F. Piscopo, ODUSD (S&T)/WS, 06/06/01

Attachment 4