METRICATION REPORT TO THE CONGRESS

National Aeronautics and Space Administration

1991 Activities and 1992 Plans

I. OVERVIEW

During 1991, NASA approved a revised metric use policy and developed a NASA Metric Transition Plan. This Plan targets the end of 1995 for completion of NASA's metric initiatives. This Plan also identifies future programs that NASA anticipates will use the metric system of measurement. Field installations began metric transition studies in 1991 and will complete them in 1992. Half of NASA's Space Shuttle payloads for 1991, and almost all such payloads for 1992, have some metric-based elements. In 1992, NASA will begin assessing requirements for space-quality piece parts fabricated to U.S. metric standards, leading to development and qualification of high priority parts.

II. 1991 ACTIVITIES

A. Policy Development

In June 1991, the Administrator signed NASA Management Instruction (NMI) 8010.2A, "Use of the Metric System of Measurement in NASA Programs." This NMI implements Public Law 100-418 and Executive Order 12770 by stating NASA's metric use policy and establishing responsibilities for defining and implementing the NASA Metric Transition Plan. The NMI strengthens NASA's previous metric use policy, and formalizes and extends an interim policy letter written by the NASA Deputy Administrator in July 1990. In particular, NMI 8010.2A designates the metric system of measurement as the preferred system for all NASA programs, while recognizing that hardware developed with inch-pound units must continue using this system of measurement. In 1991, two NASA field installations updated existing metric use policies to be consistent with this NMI. The remaining installations are expected to do so in 1992.

The NASA Metrication Planning Group (NMPG), a Headquarters committee with representation from all appropriate program and institutional offices, continues to serve as the focus for both metric use policy development and coordination of metric transition planning. During 1991, the NMPG assisted in preparation of the NMI, the NASA Metric Transition Plan, and a Metric Waiver Process.

Effective September 30, 1991, the NASA Supplement to the Federal Acquisition Regulations (FAR) implemented metric policy into NASA acquisition regulations through references to NMI 8010.2A and recent metric system additions to the government-wide FAR. The new paragraph makes "requiring activities responsible for designating the system of weight and measures applicable to each requirement."

B. Planning and Program Evaluation

1. Metric Transition Plans

Following the example set by the Office of Space Science and Applications (OSSA) in 1990, other major NASA Program Offices developed metric transition plans during 1991. NASA integrated these individual Program Office plans into an overall NASA Metric Transition Plan approved by the Administrator on February 20, 1992. The NASA Plan provides the structure that NASA field installations and individual programs will use during 1992 to formulate more detailed metric implementation plans.

The NASA Headquarters Program Offices listed in Table I below have approved Metric Transition Plans. The plans of the Office of Space Flight (OSF), Office of Aeronautics and Space Technology (OAST), and OSSA reflect assessments of programs already underway and projected new starts through the year 2000. The measurement system guideline established for each program in Table II (on following page) is a projection based on current knowledge of program definition. Final determinations will be made during the formal program development process.

In 1991, the Office of Management Systems and Facilities developed a transition plan for training, supply and equipment management, and facilities engineering. Because these areas are common to all flight and ground programs, this Plan addresses them across individual program and institutional boundaries.

Table I. Approved Program Office Metric Transition Plans

NASA Headquarters Program Office	Approval Date
Space Science and Applications (OSSA)	September 1990
Space Flight (OSF)	April 1991
Aeronautics and Space Technology (OAST)	July 1991
Management Systems and Facilities	October 1991

The strategy used in the NASA Plan integrates metric transition with the established planning and approval process for hardware development programs that are a large part of NASA's activity and budget. The internal metric initiatives targeted for completion by the end of 1995 should be adequate to establish the widest practical use of the metric system within NASA consistent with the availability of required external support capabilities. To minimize disruption and risk to ongoing activities, NASA allows established programs to continue using the inch-pound system. Thus, introduction of the metric system into new flight programs controls the pace of the metric transition.

Table II. Anticipated Metric System Use by Future NASA Development Programs

Office	Major Program	Start Date	Anticipated Metric Use
OSF	Space Station Freedom	Ongoing	Hybrid measurement systems
	New Launch System*	1993	Evaluating metrication impacts; decisions will be made in 1992.
	Assured Crew Return Vehicle*	1995	Under evaluation
OSSA	Space Infrared Telescope Facility	1995	Metric telescope, instruments, and spacecraft systems
	Stratospheric Observatory for Infrared Astronomy	1996	Metric telescope and instruments; inch-pound aircraft systems
	Orbiting Solar Laboratory	1998	Metric instruments, hybrid spacecraft due to inherited inch-pound hardware
OAST	Aeronautics Research and Technology	Ongoing	Needs Multiproject Waiver.
	Space Research and Technology	Ongoing	The metric system shall be used when programs being supported use the metric system; some projects and aeronautics-related base research and technology may require exceptions.
	National Aero-Space Plane	1993	NASP may use the metric system; some program elements will require exceptions.
	Space Exploration Initiative**	1997	Major flight projects use the metric system; some technology development may require exceptions.
OSO	Tracking and Data Relay Satellite II	1993	Hybrid spacecraft using inherited inch-pound hardware

* Now managed by the Office of Space Systems Development
** Now managed by the Office of Exploration

The NASA Plan allows limited but appropriate waivers or exceptions to required metric system use through specific procedures defined for individual programs, program elements, and groups of related projects. This Metric Waiver Process balances the requirement that new programs use the metric system with program cost, schedule, safety, and performance. New programs must adopt the metric system of measurement or obtain a waiver, via the prescribed process, before obtaining Authority to Proceed. NASA will authorize waivers and exceptions to required metric system use by new programs only when requests are fully justified.

The NASA Plan also addresses technical support operations and administrative functions. Transition of institutional capabilities and support functions will enable use of the metric system in program development and operations. To avoid delays and/or unnecessary spending, the pace of the metric transition for these activities will be matched to the needs established by programs. The Plan's externally oriented elements will introduce and actively support metric system use in education, public information, and small business programs.

2. Federal Coordination

NASA strongly supports government-wide metric planning through the Interagency Committee for Metric Policy and its working arm, the Metrication Operating Committee (MOC). NASA currently participates in four MOC subcommittees: construction, education, procurement, and metric practice. NASA is an active member of the MOC Steering Committee that develops and assesses government-wide transition activities.

One of the MOC's most active areas is the Construction Subcommittee. Like other Federal agencies, NASA's facility and construction needs depend totally on commercial practice. Because the standards, materials, and equipment needed for metric construction generally are not available in the United States, the Subcommittee has worked closely with industry groups to establish metric transition requirements. The Subcommittee has targeted January 1994 as the date by which the product specifications and design standards needed to submit bids for metric construction should be available to industry. NASA directly supports the Subcommittee's metric standards efforts. During 1992, NASA will begin internal planning for pilot construction projects to be done using the metric system.

Continuing interaction between NASA and the Department of Defense (DoD) on metric transition activities has involved cooperation on overall program planning, specifications, and standards.

3. Technical Assessments and Institutional Planning

All NASA field installations have appointed metrication coordinators to provide a clear channel of communications between Headquarters and the field installations for transition planning, policy coordination, and information exchange. Four installations established coordinating committees in 1991; the other installations will do so in 1992.

In 1991, two field installations completed metric surveys and prepared metric transition plans. The other installations will complete their efforts in 1992. The surveys addressed:

- metric capabilities at the installations, contractors, and suppliers.
- equipment and facilities required to support fabrication, assembly, and testing using the metric system.
- impact of metric system use on standards and specifications, supply and equipment, system development procedures, and operations.

These studies examined several approaches to metric transition ranging from the fastest practical schedule to one accomplished through routine equipment replacement, staff training, etc. The schedule implied by the plans prepared by the NASA Headquarters Program Offices appears to be intermediate between these extremes. Preliminary planning indicates there will be real costs associated with metric transition. During 1992, NASA will refine these cost estimates and begin to integrate metric transition activities into the normal program and institutional budget processes.

C. Other Accomplishments

1. Payload Support

Four of the six Space Shuttle launches in 1991 carried major NASA payloads. As shown in Table III, two payloads were hybrid (used both metric and inch-pound units), and two were inch-pound designs. The metric content of these payloads came from foreign sources. One DoD payload element, the Shuttle Pallet Satellite (SPAS), was built in Germany using the metric system. The engineering analyses and physical integration needed to prepare this hardware for flight expand NASA's metric system experience and provide a strong basis for assessing the Agency's in-house requirements for support of metric programs.

Table III. Metric Status of Space Shuttle Payloads Launched in 1991

Flight No.	Major NASA Payload	Metric Status
37	Gamma Ray Observatory	Hybrid
40	Space Life Sciences - 1	Hybrid
43	Tracking and Data Relay Satellite - 5	Inch-Pound
48	Upper Atmosphere Research Satellite	Inch-Pound

During 1991, NASA began preparing the major payloads listed in Table IV below for six Space Shuttle launches in 1992. The first five payloads are hybrid because they involve NASA's inch-pound experiments and a Spacelab module or pallet built by the European Space Agency. The sixth mission carries two NASA payloads: Laser Geodynamics Satellite (LAGEOS), a cooperative program with Italy for an upper stage and satellite that use the metric system, and U.S. Microgravity Payload (USMP) designed with inch-pound units.

Table IV. Metric Status of Space Shuttle Payloads Scheduled for 1992

Flight No.	Major NASA Payload	Metric Status
42	International Microgravity Laboratory - 1	Hybrid
50	Atmospheric Laboratory for Applications and Science - 1 (ATLAS)	Hybrid
52	U.S. Microgravity Laboratory - 1	Hybrid
46	Tethered Satellite System	Hybrid
47	Spacelab - J	Hybrid
52	LAGEOS USMP	Metric Inch-Pound

2. Education Publications

In a significant decision, the NASA Education Program decreed that all future materials produced for primary through high school students and teachers will use the metric system of measurement. Table V (on the following page) lists six publications to be published in 1992 that use the metric system.

Table V. Metric Status of NASA Education Publications in Production

Publication	Title	Metric Status
EP-276	Ship to Shuttle	Inch-pound with metric appendix
EP-279	Space Suit Teachers Activity Book	Metric
EP-280	Microgravity Teachers Guide	Metric
EP-281	SEEDS: A Celebration of Science	Metric and inch-pound
EP-282	ATLAS - 1 Teachers Guide	Metric
SP-510	NASA's Solar System	Metric

D. Supporting Activities

1. Manpower Levels

In 1991, the number of NASA personnel involved in metric transition planning increased significantly. Program Offices at NASA Headquarters and all NASA field installation have designated metric coordinators. At least 100 NASA personnel are members of planning groups at NASA Headquarters or field installations. Detailed assessments supporting the planning involve a growing number of personnel. Involvement will expand further where the metric system is chosen for the major programs listed in Table II. Participants currently come from many different disciplines including engineering, procurement, supply and equipment, and training personnel.

NASA Headquarters conducted the early metric transition planning activities. To stimulate full Agency involvement, metric coordinators and other key personnel at all NASA field installations participated in a September 1991 videoconference to review the status of NASA's metric transition planning. Presentation topics included interagency activities, NASA policies, field installation transition planning, pilot projects, and government plans for construction of facilities. During 1992, NASA will have additional videoconferences and meetings to foster exchanges of ideas and sharing of capabilities among field installation personnel.

2. Pilot Projects

Small flight experiments provide an excellent opportunity to gain early hardware experience with the metric system. This experience is valuable for identifying support requirements and assessing barriers to metric system use. During 1991, NASA defined a

small technology experiment for a Space Shuttle payload using metric units and completed the preliminary design. The mechanical design required some additional time but identified only two problems: no U.S. supplier of metric threaded fasteners and a lack of adequate metric reference sources for physical properties of materials. These issues are addressed in the transition activities for 1992. Discussions have identified additional pilot projects that could be initiated during 1992.

III. PLANNED 1992 ACTIVITIES

A. Metric Parts Development and Qualification

Threaded fasteners are widely used standard parts in all NASA flight and ground systems. Although U.S. metric standards exist, manufactured parts are available only by special order. NASA requires large quantities of fasteners encompassing a variety of materials, configurations, and coatings. At the end of 1991, NASA started a fastener requirements and qualification project to procure and qualify selected metric fasteners. The requirements of individual pilot projects designed using the metric system will be the starting point for defining a set of common piece parts in metric sizes. This project is coordinated with NASA-wide mechanical parts program newly initiated by NASA's Office of Safety and Mission Quality. Availability and cost comparisons will be made between equivalent metric and inch-pound parts. Design and assembly data (e.g., torque and lubrication requirements) will be developed and published to provide engineering reference data for future programs.

Spacecraft use fluids for propulsion, attitude control, thermal control, and life support functions. Availability of suitable metric fittings for ground processing and servicing of international payloads has been an issue for several years. NASA will begin a fluid coupling requirements and qualification project in 1992 focusing on the needs of payloads launched by NASA. This project will survey the variety of current and projected space hardware, determine needs for metric fluid system parts, and work with national standards organizations such as the Society of Automotive Engineers to develop the required metric standards.

B. Pilot Projects and Field Installation Involvement

Personnel training in metric system use is a common need across NASA. Administrative support personnel require a general familiarity with common metric units, while engineering staff require more detailed knowledge to use metric units routinely. Training requirements will be identified for different groups of NASA personnel; pilot training courses will be developed and implemented. These courses will make maximum use of private sector materials and capabilities to establish common training modules for NASA-wide use, thereby avoiding duplication in course development. Training will begin in

1992 on a trial basis at several NASA field installations prior to full implementation in 1993.

All field installations will complete metric surveys and prepare individual metric transition plans during 1992.

C. Federal Coordination

NASA will continue to participate actively in the MOC and its subcommittees during 1992.

D. Payload Support during 1992

The scheduled Space Shuttle flights for 1992 will carry the five hybrid and one metric payloads identified in Table IV. During 1992, NASA will begin integrating major payloads (Table VI) for 1993; half involve hybrid measurement systems. The payload elements using the metric system are the module for Spacelab-D2, the Spacelab pallet for ATLAS-2, and the Shuttle Pallet Satellite (SPAS) payload carrier for Orbiting and Retrievable Far and Extreme Ultraviolet Spectrometer (ORFEUS).

Table VI. Metric Status of Space Shuttle Payloads for Post-1992 Launches

Flight No.	Major NASA Payload	Metric Status
54	Tracking and Data Relay Satellite - F	Inch-Pound
55	Spacelab - D2	Hybrid
51	Advanced Communications Technology Satellite ORFEUS-SPAS	Inch-Pound Hybrid
56	ATLAS - 2 Spartan - 201	Hybrid Inch-Pound