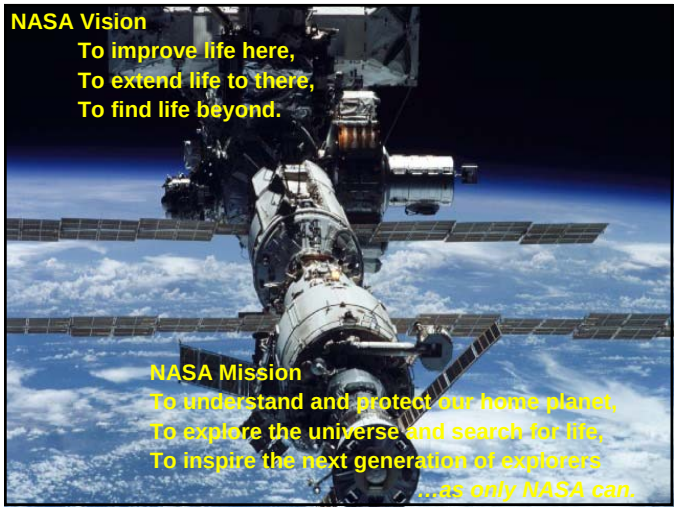
NASA Deferred Maintenance (DM) Parametric Estimating Method

The NASA Mission -

To understand and protect our home planet

To explore the Universe and search for life

To inspire the next generation of explorers



NASA Vision

To improve life here,
To extend life to there,
To find life beyond.

NASA Mission

To understand and protect our home planet,
To explore the universe and search for life,
To inspire the next generation of explorers
…as only NASA can.

NASA Real Property

- **2800+ Buildings**
- **2600+ Other Major Structures**
- **$21 Billion Current Replacement Value**
- **44 Million Square Feet**
- **Over 100,000 Acres of Land Owned + 100,000 Acres in lease-hold interest.**
- **Over 400 Miles of Roads**
- **Over 750 miles of electrical distribution lines**
- **Over 450 miles of water and sewer lines**

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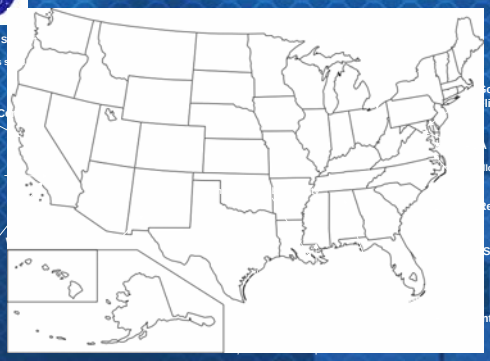
NASA Locations



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Vehicle Assembly Building – Kennedy Space Center

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Shuttle Service Structure

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Deep Space Network 100m Antenna

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NASA Challenges

- **Changes in NASA Operations.**
  - Full Cost Management.
  - Integrated Financial Management Program.
  - Drive for more accurate, more meaningful metrics.
  - Calculating "Return on Investment."
  - Competitive Sourcing (President's Management Agenda).
  - "Freedom to Manage"

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Changes in Facilities Engineering Focus

- **Corporate ownership of capital investment**
- **Full Cost Management**
- **Reduce Infrastructure**
- **Put "under-utilized" infrastructure to work for NASA**
- **Sustain remaining NASA physical infrastructure**

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Why NASA Considered a New Method

- Auditors questioned NASA traditional Backlog of Maintenance and Repair (BMAR) estimates in NASA Accountability Reports
  - Methods not auditable, repeatable
  - Costly; up to $1.50 per square foot

Historical Perspective

- Need method that:
  - Is low-cost
  - Can be updated annually
  - Is auditable to a reasonable degree
- How information is used impacts required degree of fidelity
  - According to the needs of the Agency financial statement
  - Project estimate – accurate to the dollar

Low-cost, Consistent, Auditable

Purposes

- To provide a consistent, auditable DM estimate
- To provide an assessment of the general condition of NASA facilities from the system level.
- To provide a facility performance metric which can be compared to, and trended against, other commonly used facility metrics.

Estimate Valid Over a Large Number of Facilities

What's Industry Doing?

- Spring 2000 - Federal Facilities Council reviewed potential methods
  - Traditional condition assessment surveys
  - Total life cycle cost method
  - 7 other "parametric" methods
- Industry facility condition assessment firms seeking lower cost alternatives for their clients

DM Method

- **Corps of Engineers PACES system & R.S. Means are major data components**
  - **FCI tied to % value of each major system**
  - **Major Systems tied to % value of entire facility**
- **PACES is a compilation of billions of $ of all types of construction over many years**
- **Model provides both FCI & DM $**
- **National accounting firm reviewed NASA method and assumptions**

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Procedures

- Rapidly inspect 9 systems in each facility
- Rate condition of each system (5 point scale)
- Convert condition ratings to DM estimate based on facility Current Replacement Value (CRV)
- Model accounts for 40+ different facility types

DM Cost Estimate, FCI, & SCI

Facility Systems

- 9 Facility Systems
  - **Exterior finishes** – walls, windows, doors
  - **Roof –** roof, gutters, flashing
  - **Structure** – foundations, slabs, floors, pavements
  - **Interior finishes** – floors, walls, ceilings, doors, stairs
  - **Plumbing** – water, sewer, fire protection piping
  - **Electrical** – distribution, lighting, other wiring/controls
  - **HVAC** – HVAC and other mechanical systems
  - **Conveying** – cranes, elevators, hoisting equipment
  - **Program Support Equipment** – test, research, program equipment

Condition Assessment Scale

- 5 Condition Ratings
  - 5 (Excellent) – Only normal scheduled. maint. required
  - 4 (Good) – Some minor repairs needed; functions okay
  - 3 (Fair) – More minor repairs required; mostly functional
  - 2 (Poor) – Significant repairs required; system not fully functional for bldg use; does not meet all codes
  - 1(Bad) – Major repair or replacement required to restore function; system unsafe
  - 0 (Absent) - A system that does not exist in a facility

Typical System Condition Percentages

SYSTEM	5	4	3	2	1
STRUC	0	1	10	25	150
EXT	0	1	10	50	101
ROOF	0	9	38	75	150
HVAC	0	2	13	63	133
ELEC	0	2	13	63	133
PLUMB	0	2	10	57	121
CONV	0	2	13	50	100
INTF	0	1	10	50	101
EQUIP	0	2	13	50	100

Based on *RS Means* Estimating Tools and Survey of Actual Maintenance and Repair Cost

Facility Category Codes

- R&D and Test Buildings
- R&D Structures and Facilities
- Administrative Buildings
- Communications and Tracking Facilities
  - Large Antenna
  - Small Antenna
- Launch Pads
- Lighting
  - Electrical Distribution
  - Power Generation
  - Substations
- HVAC Distribution
  - HVAC Generation
- Potable Water Distribution
  - PW Treatment Plants

DM Facility Category Codes Designed to Account For As Much CRV as Possible

System Current Replacement Value Percentages

DM Codes	NASA Building	Structure	Exterior	Roof	HVAC	Electric	Plumbing	Conv	Interior Finishes	Equip
1	R& D and Test Buildings	.18	.19	.04	.15	.20	.04	.01	.15	.04
2	R&D Structures And Facilities	.40	.17	.01	.06	.25	.02	.02	.03	.04
3	Wind Tunnels	.30	.05	.01	.01	.15	.01	.01	.01	.45
29	Berthing And Housing	.15	.17	.09	.16	.18	.07	.02	.16	0

Based on DoDs *PACES* model

Deferred Maintenance Calculations

- Estimate calculated by adding weighted average of the nine systems.

	System	System %	System CRV %	System Rating	System Condition %	CRV Deferred Maintenance
A	Structure	0.18	1,800,000	5	0.00	0
B	Exterior Enclosure	0.17	1,700,000	4	0.05	85,000
C	Roof	0.05	500,000	4	0.05	25,000
D	HVAC	0.16	1,600,000	3	0.15	240,000
E	Electrical	0.18	1,800,000	4	0.05	90,000
F	Plumbing	0.05	500,000	3	0.15	75,000
G	Conveying	0.06	600,000	5	0.00	0
H	Interior Finishes	0.15	1,500,000	3	0.20	300,000
I	Facility Equipment	0.00	0	0	0.00	0
		1.00	10,000,000			**$815,000**

Facility Condition Calculations

- Individual Facility
- Individual Systems
- Composite Center

Facility Condition Calculation

Facility Description	2002 CRV	STRUC		EXT		ROOF		HVAC		ELEC		PLUMB		CONV		INTF		EQUIP		FCI
		Insp Rate	% Sys CRV	Insp Rate	% Sys CRV	Insp Rate	% Sys CRV	Insp Rate	% Sys CRV	Insp Rate	% Sys CRV	Insp Rate	% Sys CRV	Insp Rate	% Sys CRV	Insp Rate	% Sys CRV	Insp Rate	% Sys CRV	
	$33																			
MATERIAL/EQUIPMENT STORAGE	$52,593.00	2	0.63	2	0.17	2	0.05	0	0.15	0	0.15	0	0.15	0	0	2	0.15	0	0	2
WAREHOUSE	$1,172,019.00	4	0.4	3	0.19	2	0.06	0	0.18	3	0.2	0	0.02	0	0	3	0.15	0	0	3.34
COVERED STORAGE	$102,267.00	5	0.63	5	0.22	5	0.11	0	0.03	5	0.04	0	0.01	0	0	0	0.04	0	0	5
GENERAL WAREHOUSE	$7,781,631.00	4	0.6	4	0.15	4	0.1	3	0.04	3	0.06	4	0.01	0	0	4	0.04	0	0	3.9
ADMINISTRATION BUILDING	$12,166,903.00	5	0.19	5	0.17	3	0.06	4	0.16	4	0.18	4	0.05	5	0.03	5	0.16	0	0	4.49
AUDITORIUM	$6,306,944.00	3	0.22	4	0.17	4	0.06	4	0.16	2	0.18	4	0.05	0	0.03	2	0.16	0	0	3.1
MAIN LIBRARY	$5,716,090.00	5	0.19	4	0.17	4	0.06	4	0.16	4	0.18	4	0.05	4	0.03	4	0.16	0	0	4.19

Qualitative and Quantitative Analyses

- Multi-variant statistical analysis
  - Used statistical correlation theory, equal variance theory, and color histograms
    - Validate results
    - Test for consistency between teams
    - Multiple sites assessed by multiple teams

Whitestone Research commented that the degree of consistency between teams was exceptional

Qualitative and Quantitative Analyses

- Statistical comparison to BUILDER based upon Army Research Laboratory at Adelphi MD
- Statistical comparison to VFA Facilities based upon National Naval Medical Center, Bethesda, MD.

USACE ERDC CERL performed the analysis

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Other Highlights

- New Management Features in the Database
  - DoD Facilities Sustainment Model (FSM)
  - Facilities Incremental Condition Change Model (FICC)
- GPS Data gathered on each facility

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Conclusions

- The DM parametric estimate provides a low-cost consistent, auditable method of evaluating the condition of facilities and provides a method to evaluate the relative condition of the Sites.

The Method is Rapid, Low-Cost, Consistent, and Auditable

Current Actions

- NASA now applying Navy's Mission Dependency Index, a risk management based criticality factor for each facility.
- Master plans, construction plans and maintenance plans are incorporating DM model results.