W76 Warhead / Mk4 RB / UK Trident RB

Overview

"W76/Mk4 is the most critical element of our nation's strategic deterrent and cannot be allowed to be degraded by a serious aging problem" (LANL W76-1 overview www.lanl.gov/orgs/d/d5/projects/W76/W76-1-LEP-Overview.htm)
W76/Mk4 RB entered stockpile in 1979; "The Mk4 Reentry Body is the mainstay of our nation's nuclear deterrent" – Duke Williams, Space Systems chief engineer for Navy Reentry Systems. (Space Daily 11 July 2000)
Entered service November 1978 (Stockpile Stewardship Program 30 day review DOE 23 Nov 99)
US W76 produced until 1987 (www.globalsecurity.org)
- so 20 year life for stockpile at 1998 - 2007

Dual revalidation
Began in 1996, major system tests due for FY1998 and FY1999. 6 hydrodynamic tests, 15 AF&F tests.
Showed "even though components are aging gracefully, there are some negative changes" (LANL W76-1 overview www.lanl.gov/orgs/d/d5/projects/W76/W76-1-LEP-Overview.htm)
Completed (Stockpile Stewardship Program 30 day review DOE 23 Nov 99)
Dual revalidation scheduled for end of 20 year life of first warheads.
Drew to a close in Dec 1999, areas:
(a) System Level Assessment – STS including safety and hostile
(b) Primary Physics Assessment – 5 hydrodynamic tests, 2 using stockpile aged HE, one point safe assessment
(c) Secondary Physics Assessment – progress made in baselining and benchmarking secondary
(d) Physics Package Engineering Assessment – test of ability of secondary to withstand revised long-term shipboard vibration environment, HE testing, aged physics package disassembled and components tested.
(e) AF&F – 19 AF&F disassembled and tested. Age aware model of fireset completed. Most AF&F hostile testing complete
All these areas became priorities for ASC

W76 yields were readdressed for the dual revalidation effort (FY01 appraisal UC/LANL)

Alt 317
Involves replacing the NG, and Acorn (not official)
Scheduled for FY98-02 (figure, stockpile life extension schedule)

W76-1
SSP requested and Nuclear Weapons Council Standing and Safety Committee approved a DoD/DOE study (6.2/2A) initiated on 19 Oct 1998. Study conducted under the W76/Mk4 Project Officers Group (POG). POG results briefed to NWCSSC in Dec 1999 and to NW Council in March 2000. Ground rules for study:
Nuclear detonation safety features to be modernized to Mk5-like interface;
Current W76 Military Characteristics and STS were baseline;

One-time refurbishment;
Production goal of 10 years;
Post refurbishment life extension of 30 years.
The chosen refurbishment option will also provide increased "targeting flexibility and effectiveness". (LANL W76-1 overview www.lanl.gov/orgs/d/d5/projects/W76/W76-1-LEP-Overview.htm)
Block 1: around ¼ of warheads, FPU FY2007 & production to be completed FY2012, will focus on HE, detonators, organic materials, cables, new Acorn GTS and new AF&F. During this a decision will be made whether to extend this to entire W76 stockpile, change to a Block 2 retrofit, or not continue. If Block 2 was approved it would be from FY2012 to FY2022. (www.globalsecurity.org)

Life extension study of W76/Mk4 RBA by SNL, LANL, SSP, STRATCOM, LMSC and ITT identified design options, production plans and cost estimates. SNL conceptual design for AF&F expected to meet target of ½ W88 AF&F cost. (Sandia Lab News 11 Feb 2000)
W76 phase 6.2 study complete (FY2001 appraisal of UC/LANL)

In FY2003 6.3 (development engineering) to continue and 6.4 (production engineering) to start; Conceptual design review FY03 (FY03 DOE NW budget Directed Stockpile Workload)
In FY2004 first 45% of 6.3 to be complete, including flight test bodies for FCET 32, and first 10% of 6.4.
Full Scale Engineering Development to be completed FY2006-07 (FY03 DOE NW budget Campaigns)

Normal environment and model validation successful August 2003, first qualification of Mk4A RB design (Sandia Labs Accomplishments 2004)

Complete certification of a W76-1 warhead with qualified design margins and uncertainties by Sep 2007 by LANL/SNL (QMU milestones)
FPU FY2007
Develop Qualitative Margins (QMU) logic for W76 simulation by FT2004 and QMU work for W76 to be 100% complete by FY2009. (FY05 DOE NW Weapons Activities budget)

ASC STS (prob W76) –
STS abnormal FY04; Initial Validated (IV) STS hostile FY2005; IV STS normal FY2005; Coupled STS abnormal FY08; (FY05 DOE NW Weapons Activities budget)

Normal/Hostile/Fratricide STS (ASCII DP50 budget brief FY99)

Validation and Verification work for W76-1 – validation for blast/impulse in hostile environment. (FY05 DOE NW Weapons Activities budget)

SALINAS used to simulate W76 system's response to hostile radiation (Sandia Annual Review 2002/03)

Arming Fusing and Firing System

Mk5 AF&F assembly includes radar, programmer, accelerometer, deccelerometer, thermal batteries, fire set, contact fuze and a force balancing integrated accelerometer. It contains over 3000 parts

MC2912 Arming Fuzing and Firing System (W76-0)
AF&F includes: arming/safing System, fuzing system and firing system. (SNL pic)
The AF&F integrates the Navy arming and fuzing sub-systems with the DOE firing sub-system and includes safety features to avoid accidental detonation. Photo. (www.sandia.gov/Nuclear.htm)
3 million degree of freedom finite element model created using SALINAS code (SNL, photo)
DOE model of W76 sprytron "E028Q1" models reliability re Flare Dud.
DOE model of W76 Programmer/sequencer "E898X5" models reliability re Flare Dud.
DOE model of W76 Timer "BHOHL" models reliability re Height of Burst.
Timer is key component given speed of RB, importance of HoB, and need for back up fuse systems.
W76 power management circuit model listed on non-nuclear codes roadmap, under FY99 (ASCI DP50 budget brief FY99).

MC4700 AF&F (W76-1)
In 1995 options for extending the life of the AF&F were to be developed including consideration of radiation tolerance. (www.doe.gov/rnd/data/22406.html)
Over 300 design options considered using high performance computing, to select AF&F redesign. (Sandia Lab News 11 Feb 2000)
Design and manufacturing cost targets for future AF&F identified (Statement by Paul C Robinson on Stockpile Management, 26 Feb 1999, www.sandia.gov)
W76-1 Arming and Fuzing Subsystem (AFS) includes radar, flight computer and diagnostics (Sandia Lab News February 2003)
The driver of the High Performance Electrical Modeling and Simulation (HPEMS) project is to develop a model to design and certify the arming and fuzing system of the W76-1 in an STS environment, in particular the Main Logic Board, Timer (FPGA) and radar, by May 2002. (?)
Modeling of effect of x rays on a circuit in MC4700 carried out using Xyce by May 2003. In FY2004 plan to calculate internal x ray radiation in MC4700 with Xyce.
80% of work in AF&F sub assembly at ¼ cost was to be carried out by FY2004.
A main focus for Advanced Design & Production Technologies was production of subassemblies for W76 AF&F (FY05 DOE NW budget, Readiness Campaigns)

MC4702 is the firing subsystem in the W76-1/Mk4A, a report on the time-to-fire for the MC4702 was written by Paul Dimmie in July 2002 (Sandia Publications)
Need to determine time MC4702 has to initiate detonators before a component becomes inoperable re contact fuze – in FY2001. Simulated 8 velocity-angle points of impact.

FY2003 item - to develop a weak-link capacitor design for W76 & W80.

For FY2002 – model foam decomposition in abnormal thermal environments.

For FY2003 – Critical to qualifying the AF&F in abnormal environments is delivery of a validated capability to predict the fire-induced response of confined foam. (FY03 DOE NW budget Campaigns)
W76 & W80 AF&F use a Removable Epoxy Foam (REF) for encapsulation. Concern about decomposition and response to fire. Chemical model developed for decomposition and then heating modelled. REF also encapsulates components within firing set which are thermally and mechanically sensitive. Fire response of foam in this area is important.
Radiation hardening of the W76-1 will require 60 shots in one year. (Pulsed Power Peer Review 2000)
Tests conducted at Sandia Pulse Reactor for AF&F (FY03 DOE NW budget Directed Stockpile Workload)
Fabrication and testing of functional prototype radar in FY2003. (FY03 DOE NW budget Campaigns)
Delivered 3D prototype codes for normal and hostile STS, these codes will play a major role in AF&F manufacture – past achievement Fabrication and testing of functional prototype radar in FY2003. (FY03 DOE NW budget Campaigns)
Target date for virtual prototype of W76 AF&F FY2003 (W76-1?) (early graph)
SRS test for W76 AF&F in FY03 (FY03 budget)

AF&F Components

Contact fuze (W76-1)
In support of FY01 ASCI Normal Environment Level 1 milestone, the ALEGRA code development team successfully completed calculation of contact fuze electromechanical operation during target impact at termination of flight for a W76 RB. Showcased the Adaptive Mesh Refinement (AMR) and Arbitrary Lagrangian-Eulerian (ALE) capabilities of ALEGRA code. (SNL, photo, & old AF&F model)
ALEGRA to be used for simulation of MC3819 W88 contact fuze by September 1999 (Quarterly report for Alegra Jan 1999, SNL)
Work on W76 impact fuze simulator using ALEGRA carried out by Randall M Summers.
ASC FY01 Q4 – 3D shock physics and electromechanical response of contact fuze operation at termination of flight (ASC ..)
Modelling of collisions of W76-1/Mk4A with irregular targets carried out in FY2001.

MC2823 radar (W76-0)
Suspected material problems – notes – customer preferred fuzing options, solid state electronics, corrosion concerns, complex technology.
(System analysis of non-nuclear components slide)
DOE model of W76 radar "E823F" models reliability re Height of Burst.
W76 fuze revalidation scheduled for FY2000 as a modelling prototyping item (early graph, 10 TeraOps)

Radar (W76-1)
Model of radar fuze for W76-1 to be produced in EMPHASIS by Q4 FY2001 (ASCI Q3 FY2001 report)

MC2936 Battery (W76-0)
Suspected material problems:

MC2936 Battery Thermal Ca (within AF&F ?) – notes – critical function, energetic materials, reactive materials, hermetical concerns. Modelling emphasis relevant for this – TMF/local corrosion/diffusive emb, materials interfaces, energetic material decomposition, ceramic stress corrosion/fatigue. Also described as Ca/CrO4
(System analysis of non-nuclear components slides)

MC3028 Firing Set (W76-0)
Firing sets use Capacitor Discharge Unit (CDU), these accumulate electrical energy from a low voltage supply in a high voltage capacitor bank and deliver this energy to fire high-energy detonators.
They also initiate NG operation.
AF&F systems include a computerised programmer that controls all initial weapon commands. Programmer enables other activities such as electrical arming and gas transfer.

Comprehensive, coupled 3D age-aware model of the explosive firing set in W76 & W78 developed in support of stockpile surveillance and Dual Validation. (Sandia Lab News 11 Feb 2000) There is also a reference to developing a new detonator for W76 and W78. (www.doe.gov/rnd/data/22641.html)
ALEGRA used for MC3028 fireset aging simulation due for March 1999. (Quarterly report for Alegra Jan 1999 SNL)
Successfully predicted behaviour of aging HE (W76 Fireset) (ASCI DP50 budget brief FY99)
MC3028 Firing set for W76 & W78 - revalidate publication and life assessment by Nov 2002.
A report on the revalidation and life assessment for the MC3028 firing set was written by Paul Demmie in July 2002 (Sandia publications list)
Report on modelling and simulation of MC3028 written by Paul Demmie in August 2002 (Sandia publications list)

Suspected Material problem:
MC3028 Firing Set SFE – notes – critical function, energetic material, dielectric, organics. Model emphasis relevant to this – materials interfaces, energetic materials, decomposition, polymer degradation and failure, ceramic stress corrosion/fatigue.
3D age-aware modelling of MC3028 Slim-Loop Ferroelectic (SFE) firing set carried out in FY2000 including effect of including mylar layers. (poss for W76-1)
MC2983 Trigger circuit – notes - krypton, sprytron, glass insulators (firing set ?)
Model emphasis relevant to this – TMF/local corrosion/diffusive emb, polymer degradation and failure, ceramic stress corrosion/fatigue.
(System analysis of non-nuclear components slide)

Fireset (W76-1)
Fabrication and testing of functional prototype fireset in FY2003. (FY03 DOE NW budget Campaigns)

Light-initiated HE project mothballed in 1992 revived for W76-1, qualification testing slated for 2006 (Sandia Labs Accomplishments 2004)
Completion of development of a laser fired fiber optic controlled detonator is planned under enhanced surety for W78 and future SLBM warheads (FY05 budget)

MC2854 & MC 2897 Environmental Sensing Devices (W76-0)
Suspected material problems:
MC2854 ESD- Accel (fluid) – notes – safety critical, hermetic seals and fluid aging concerns
MC2897 ESD* – Decel (escapement) – notes – safety critical, springs and lubricant concerns
Modelling emphasis relevant to ESD – TMF/local corrosion/diffusive emb, materials interfaces, polymer degradation & failure, ceramic stress corrosion/fatigue, lubricant degradation.
Environmental Sensing Device (ESD) to sense low levels of acceleration, play a key role in NW safety architectures that use environmental sensing as part of their nuclear safety theme. Motion of the ESD spring and sense mass is fluid damped to assure smooth long-term operation (Sandia Lab News Feb 2003)
This system is probably used as a safety feature – the warhead can only be armed after going through the acceleration of a launch and the deceleration of reentry

Neutron Generator

Neutron Generator helps to initiate the fission reaction in a warhead. Because it uses tritium it must be replaced regularly.
"The proper function of a nuclear weapon depends on the presence of neutrons during primary implosion when the plutonium is supercritical. Neutron generators are located close to the warhead primary to produce a sufficient quantity of neutrons at that critical time." (SNL Accomplishments - Nuclear weapons)
NG functions as a minature linear accelerator to produce deuterium-tritium reactions to generate neutrons. They have to be able to withstand environment of RB and contain exotic materials. (www.globalsecurity.org)

Achieving NG standoff is listed as a key milestone in computer support for nuclear weapons. Paul Robinson said in 1997 that Sandia "recently completed three-dimensional simulations and experimental correlation of the neutron generator standoff phenomenon for the Warhead Protection Program Pit Reuse warhead." (Statement by Paul Robinson Sandia 1997) One chart shows a FY1997 milestone - NG Standoff (WPP) Another part of the same document refers to "NG standoff for contact fuze mode". Another chart has a 1997 milestone - NG Standoff (W76).

MC2989 (W76-0)
SNL four year Recertification program. Moved from Pinelas, Florida, to SNL in 1994. Three stages of recertification:

(a) Dissassembly – separate timer from NG and both cleaned.
(b) Recertification & testing – X rayed, inspected to check for damage in disassembly, random sample tested for neutron output.
(c) Conversion – NG attached to a new timer. (Sandia Lab News 15 January 1999)

During one year (1998?) SNL equipped 900 MC2989 with new hardware (SNL Accomplishments - Nuclear weapons)
Processing began for NGs returned from the field for re-acceptance and re-use (Statement by Paul Robinson Sandia 1997)

Stand off may also to point to pinus.

is key contact fuze issue is NG funding

MC4380 (W76-0 Alt317)
MC2989 described as nearing end-of-life in 1996. At that time the target for replacement was October 1999. (www.doe.gov/rnd/data/35858.html)
Code for MC4380 developed FY97-98, application FY98-99. (Sandia Lab News 28 Jan 2001)
A chart shows a milestone for NG Performance (MC4380) in FY1999.
First production lot of neutron tubes accepted by DOE and on target for first production unit of NG for Oct 1999 (Statement by Paul C Robinson on Stockpile Management, 26 Feb 1999)
Qualification of MC4380 NG completed (Sandia Lab News 26 Jan 2001)
Deadline of Oct 99 for MC4380 production put W76 recertification on hold for 6 months. (Sandia Lab News 26 Jan 2001)
Development of MC4380 between Aug 2000 and April 2002, FPU May 2002, deliveries to USN and UK summer 2002 (Sandia Lab News Feb 2003)

MC4380 along with its MC4378 timer, MC4705 voltage bar, MC4148 rod, MC4437 current stack and MC4277 neutron tube were qualified for use on W76. This is the first weaponised NG with a focused ion-beam neutron tube which should give higher reliability. Produced at Sandia and the first Sandia component with radiation hardness requirements to be qualified without underground testing. (Sandia Lab News 11 Feb 2000)

During one year (1998?) SNL fabricated 82 MC4368 subassemblies for MC4380, and tested 60 MC4380 NGs. Fabrication of MC4380 started in December 1996. (SNL Accomplishments - Nuclear weapons)
800 targets for use in W76 NG manufacture produced by LANL (FY01 appraisal of UC/LANL)

Simulation of various radiation effects on the NG. This included modelling x ray radiation transport throughout an RV simulated for the first time in 3D. Code developed FY1997 and FY1998, applied in FY1998 and FY1999 with qualification due in early FY2000. Carried out using TeraFlop computer. Using an updated version of the 20 year old Monte Carlo radiation transport code. (Sandia Lab News 28 January 2000)
This process was used to trial certifying components in radiation hardness in the absence of nuclear testing. There is also reference to designing a shield for the NG. (www.doe.gov/rnd/data/35854.html)
"this will be the first time that a major component of US nuclear weapons will be introduced into the active stockpile without being qualified through nuclear tests."
(Statement by Paul C Robinson on Stockpile Management, 26 Feb 1999, www.sandia.gov)
Certification simulation for Mechanical Response of W76 replacement NG carried out on ASCI Red in FY98 (ASCI DP50 budget brief FY99)

MC4380A Neutron Generator (W76-0)
SNL developed MC4300 neutron tube - ½ size of neutron tube in MC4380, prob not for W76 (Sandia Lab News 12 Feb 1999)

FY04 targets for limited life components, including replacement of MC4380A:

388 new build NGs, 1861 new build reservoirs, 1734 filled reservoirs, 131 gas generators (all warhead types) (FY04 budget)

Gas Transfer System

GTS boosst the yield of a fission reaction by facilitating the fusion of hydrogen isotopes. (Sandia Factsheet: GTS)

Acorn Gas Transfer System (W76-0 Alt317)

A new loading line (LL6) was set up at SRS for $14m with completion date due in July 1998, initially for loading W76 Acorn. (SRS Fact Sheet Loading Line Modification Project).
The previous model was Heather. Development of Acorn was ongoing in FY1996 with a planned delivery of October 1998.
First production started (Stockpile Stewardship Program 30 day review DOE 23 Nov 99)
Test which was key to certification done in Jan 2000 (Sandia Annual Report 2000)
Award received by LANL team testing W76 Acorn GTS (LANL Dec 2002)
W76 Acorn GTS was due to enter service in 1998 but "verifying it proved a challenge" - tritium loaded GTS had to be tested in realistic shock and vibration environment – had to make special arrangement to test (LANL reflections Oct 1998)

Acorn Gas Transfer System (W76-1)

References to new Acorn GTS for W76-1.
Acorn system established as the baseline technology for the W76 refurbishment (LANL Institutional plan FY03-05)

Physics Package

See PITS – requal = rebuild?

Primary

Pu – he can deform pit and modify crystal structure.
Eddy current and acoustic capabilities to be developed for the Integrated Pit Inspection Station (IPIS) for pit requalification in support of W76-1; IPIS to be implemented by FY2002. (FY03 DOE NW budget Campaigns)
Dual Axis Radiographic *Hydrotest* (DARH) – for hydrotesting of W76 under advanced radiography heading (FY05 budget)
One W76 SLEP hydrodynamic test incurred test set errors that compromised data – so will need to conduct a second test to develop data to establish a baseline for validating W76-1 models.(FY02 appraisal of UC/LANL)
Two hydrodynamic tests for W76 in FY03 (FY03 budget)
Four hydrotests scheduled for W76 in FY03 were rescheduled to later years, "hydrotests remain a concern" (FY03 appraisal UC/LANL)

Completion of reuse/remake decision on W76 case; LANL contributed significantly to the program metal make/reuse decision with Y-12 (FY03 appraisal of UC/LANL)

HE

Synthesis and formulation processes for PBX 9501 with back up capacity to be demonstrated by FY2002 (W76-1?) (FY03 DOE NW budget Campaigns)
LANL tasks in FY97 included lifetime prediction and predictive modelling for PBX9501 (Enhance Surveillance Program FY97, gpo.osti.gov)

Virtual aging – successfully predicted behaviour of aging HE for W76 fireset in DP50 budget brief FY99, 22 Feb 98 (Sandia Labs Accomplishments 2004)
"qualification of a replacement PBX9501 explosive" one focus of dynamic material heading (FY05 budget DOE NW Weapons Activities)
Equipment for HE machining, manufacture and testing for W76-1 under HE and weapons operations (FY05 budget)
Increase of $10,000 in HE and Weapon Operations heading partly to meet manufacturing requirements for W76-1 (FY05 budget DOE NW Readiness)
HE and Weapon Operation machining equipment for W76-1 production. (FY05 budget DOE NW Weapon Activities)
LANL contributed significantly to the HE make/buy decision with Pantex (FY03 appraisal of UC/LANL)

Secondary
Secondary Assessment Technologies area is developing QMU methods for assessment & certification of secondaries, with data from hydrodynamic and high energy (eg NIF) experiments. (FY05 DOE NW budget weapons activities)

Flight Test items
Flight testing (W76-0)
Development of High Fidelity JTA was funded in 1997.
The first W76 Enhanced Fidelity Instrumented-A (EFI-A) RB and Type 2G High Fidelity Flight Test unit were flown in Feb 99. This has increased understanding of missile/RB interactions, internal RB shock/vibration environments and RB dynamic behaviour. (Sandia Lab News 11 Feb 2000)
Finite Element Telemetry subsystem model created and flown successfully. Data compared with 7 US & UK tests to help develop full-system structural model.
Sandia redesigned W76-0 JTA in 2002.
W76-0 JTA achieved production status following test SAR 01 (Sandia Labs Accomplishments 2004)
JTA has 10 times data rate of predecessor (Sandia Annual Review 2001)
W76-0 JTA flight test Feb 2000, FPU Aug 2001 (www.globalsecurity.org)

Flight Tests (W76-1)
Target date for virtual prototype of W76 JTA FY02/03 (W76-1?) (early graph)
FY2004 FCET-40, support work in FY2003 (FY03 DOE NW budget Directed Stockpile Workload)
FCET for W76-1 carried out;
JTA4A-2B for W76-1, pre-flight ground qualifications for DASO-18;
(Sandia Labs Accomplishments 2004)
JTA4A-2B normal environment test was the first high-fidelity system level test using SALINAS supporting qualification of the W76-1 (Sandia August 2003)

Support for DASO 18 for W76 in FY03 (FY03 budget)
Flight test bodies for FCET 32 to be delivered in FY04 (FY04 budget)
Flight test of HE response for FCET-34 – abnormal/hostile response to be developed (FY05 budget)

Seals
Investigations carried out into ageing of Butyl Rubber O rings on W76.

Modeling of loss of material integrity of butyl rubber O rings in W76 & W87 carried out (ASCI DP50 budget brief FY99)

RB cases

Production of Mk4 RBA hardware kits used to house nuclear warheads completed in July 2000 after 23 year production run started in 1977. More than 5,000 RBA kits made for US and UK. LMSC Missile and Space provides the RB aeroshell, RF subsystem, nose-tip and release assembly. (Space Daily 11 July 2000)

RB Case (W76-1)

Navy and DOE are planning a general life extension program for the W76/Mk4, including RBs work will be completed by 2020 for life until 2040, LMSC will retain production tooling for RBA hardware. (Space Daily 11 July 2000)
Contract issued to develop a replacement RB heat shield materials, 60% emphasis on Mk4 and 40% on Mk5, & tooling including to wrap aft heatshield for Mk4; work FY2004 – 2008 (N00178-03-R-1044)

Replacement warhead

SLBM Warhead Protection Program (SWPP) a Navy/DOE program to maintain the capability to develop nuclear warheads for W76/Mk4 and W88/Mk5 should they be needed in future. Currently focused on two designs, both for Mk5 RB:

(a) Pit Re-Use Project - LLNL has Nuclear Explosive Package design responsibility; Experimental and Computational Assesment through 2000; Certification/Prototyping of design through 2002; AF&F could be based on W76-1 AF&F; may include flight testing elements; likely to be based on W89-Alt recycled pit designed for SRAM 2 which was tested once before 1992, but normally 4 tests would be needed.

(b) Replacement Warhead Project – new pit; concept design 1997, experimental and computational assessment through 2002; Certification/prototyping through 2004;

Project includes prototyping and flight testing but not production
Criteria: decreased sensitivity to aging,
Increased design margin for achieving intended performance, can be by increasing Pu in pit and HE reduces safety margin; New secondary may be considered; Reorienting physics package was being considered. IHE and Fire Resistant Pit to be used.
Possible full scale engineering development of a new warhead beginning 2004.
(End Run, NRDC 1997 www.nrdc.org/nrdcpro/endrun/er3.html)

Neutron Generator Standoff (WPP) listed as item on non-nuclear codes roadmap for FY97; WPP may be Warhead Protection Program ? (ASCI DP50 budget brief FY99)

SNL with LLNL & LMSC successfully flight tested a "warhead concept" under the SWPP program, this project "investigated future options". (Sandia Annual Report 2001)

Studies

Proposal in DOE FY2004 budget for a RNEP related W76 feasibility and cost study.

SNL are part of a new Phase 6.2/2A study with the Navy for W76. (Statement by Paul C Robinson on Stockpile Management, 26 Feb 1999, www.sandia.gov)

Computer Milestones:

FY 1997: NG Standoff (WPP) / NG Standoff (W76)
FY1998: NG Rad Hard – Mech (W76)
FY1999/00: NG Performance (MC4380)
FY2000: W76 Full System, electrical system power management (W76)
FY2002: Abnormal STS (safety)
FY2003:Normal STS (performance), Abnormal STS with aging (safety)
FY2004: Normal STS with aging (Performance)

UK

Surveillance programme to extend Trident life.

Neutron Generator
MC4380 "delivery of the first units to the Navy and the UK last summer" (Sandia Lab News Feb 2003)

Recertification
In the light of four years on the W76 NG Recertification Program, SNL was hired "to do the recertification work on the neutron generator assembly in a similar British weapon". See recertification above. (Sandia Lab News 15 January 1999)

Secondary
Concerns about effect of issue with Secondaries on Life Extension, resulted in increased surveillance of secondaries around 2000.
"Historical surveillance data have revealed evidence of materials interactions that may affect performance of a secondary in the aging stockpile" – US – effects of age can vary with the background of the material – with varying degrees of initial trace impurities and thermal histories. Investigation of both surface and bulk behaviour. Particular concern with hydride formation in Uranium. Hydrogen is a source of corrosion in Uranium. Moisture in organics within the CSA can lead to a hydrogen problem, affecting the secondary. So "knowledge of the moisture content of CSA organics is essential" (Enhance Surveillance Program FY97, gpo.osti.gov)

HE
HE tests carried out to support 10+2 and 12+2 life extension.

Tests of EDC37 samples up to 12 years at temperatures 20 – 66 C;
"aged material cannot be totally mimicked by starting with lower molecular mass material. Therefore it is deduced that while molecular changes within the nitrocellulose polymer have a profound effect upon the resultant PBX mechanical properties other, as yet unidentified factors also play a role"

(The use of digital image cross-correlation (DICC) to study the mechanical properties of a polymer bonded explosive (PBX) - PJ Rae, T Goldrein, SJP Palmer, JE Field, RWP White, AL Lewis, 2002)
10 years compatible with US initial planned life of 20 years and midlife refurbishment. 12 years compatible with submarine 25 year hull-life.

Disposal of HE removed from warheads during refurbishment is an issue because it is radioactive waste.

Reviews
Timescale

W76-1 ?
Reasons for US refurbished warhead – aging concerns, non-availability of replacement components, modernize safety features. Original planned life of W76 was 20 years. Dual Revalidation showed "even though components are aging gracefully, there are some negative changes". US Stockpile Surveillance Program "cannot predict failures; rather, it only detects them when they appear"; (LANL W76-1 overview www.lanl.gov/orgs/d/d5/projects/W76/W76-1-LEP-Overview.htm)

Response to PQ about discussions between MoD and US counterparts on the development of W76-1 referred to discussions under MDA and Polaris Sales Agreement "the discussions cover all issues of mutual interest, including work on the US W76 warhead, relevant to the safety and reliability of the UK's Trident warhead." (Lewis Moonie, Hansard 6 Feb 2002)

Mason and Hanger Corporation, who operate Pantex, provided support to the UK Trident program in FY1997 which was "critical to the UK Production program". Their involvement in the US W76 is with assembly and disassembly. (Information from Don Moniak, STAND of Amarillo)

Sub critical test carried out in Feb 2002. Joint US/UK test to maintain the safety and reliability of both nations nuclear weapons. (Washington Post 15 Feb 2002). Test described as a plutonium hydrodynamic experiment in the context of the need for experiments to validate computer models. (Dr Lewis Moonie, Hansard 12 Feb 2002)

US testing requirements: one pit, one secondary, 2-5 detonator sets, 1-2 gas transfer systems, and one HE system should be tested for each weapon type each year. (NW Improvements needed to DOE NW Surveillance Program, Report to Senate Armed Services Cmte July 1996)

Nature of information exchange

Summary of JOWOGs plus other exchanges
US withholds information, eg Chevaline
UK withholds some critical information from US.

DOE has paid LANL £249,649 and SNL £1,456,785 for work for UK Trident programme in FY2001 (Adam Ingram, Hansard, 6 Feb 2002)

Notes
TMF relates to solder degradation