Fogbank

Summary

New research has identified the code name of a secret material in Trident warheads. The material called Fogbank is used in the fusion stage of the 100 Kiloton W76 warhead. A special facility was built in 2004 to remanufacture Fogbank as part of plans to extend the life of W76.

The W76 Life Extension plans have recently run into difficulty. The delay is due to serious problems with the manufacture of a Special Material. The obvious candidate is Fogbank.

Because Fogbank is only manufactured at one plant in the United States it is almost certain that Britain purchased this material for the Trident warheads which have been made at Aldermaston.

Fogbank Purification Facility

Y-12 at Oak Ridge Tennessee is responsible for manufacturing the Canned Sub-Assembly (CSA) in a nuclear warhead. The CSA is the secondary or fusion part of the weapon. Y-12 was built to enrich uranium and the facility continues to process nuclear materials. Their work also includes the manufacture of a number of non-nuclear Special Materials.

The unclassified name of one of these materials is Fogbank. From the mid-1970s until 1989 Fogbank was produced in Building 9404-11 at Y-12. A report from the Defence Nuclear Facilities Safety Board (DNFSB) in November 1993 referred to Building 9404-11 as the "Fogbank facility".[1] At this time the building was scheduled for decommissioning.

The NNSA budget produced in February 1999 included an item to "restart the existing Special Materials Facility in Building 9404-11".[2] This requirement may have arisen from studies carried out in 1995 and 1996, see below, and from the Dual Validation of the W76 warhead between 1996 and 1999, which initiated the W76 Life Extension Programme.

Restarting the 9404-11 facility was ruled out on health and safety grounds:

> "The evolution of health and safety requirements and considerations makes reuse of the original facility not viable".[3]

The DOE were planning to build a Special Materials Complex as part of a wider package of new developments. This Special Materials Complex was cancelled. However a Purification Facility to replace 9404-11 was built.[4]

The new purification facility was the first production facility to be built at Y-12 since the 1970s.[5] Construction began in 2003 and the facility cost $50 million.[6]

There are several references to the facility being 10,000 square feet within an area of 2 acres.[7] Pro2Serve, the company which designed the building, describe it as

---

[1] Y-12 Safety Analyses/Criticality/Chemical Safety Review, DNFSB, November 3-5 1993.
[2] NNSA budget for FY2000.
[3] Annual Site Environmental Report, Oak Ridge, 2003
[4] Notice of intent to prepare a site-wide environmental impact statement for the Y-12 national security complex, NNSA, 28 November 2005.
[5] BWX TYmes December 2003 / January 2004
[6] BWX TYmes December 2003 / January 2004

comprising 2,500 square feet of process space plus 1,200 square feet of administrative and support activities.[8] The earlier facility, 9404-11, was 3,226 square feet.[9] There were a number of adjacent processing buildings associated with 9404-11. This older facility was demolished in 2004.

There is a drawing of the new facility at:
http://www.y12.doe.gov/news/pdf/2002/Nov_2002.pdf

There were several changes during the design process "prompted by newly introduced project needs".[10] Completion of the facility was a target for FY2005 but this target was not met until the first quarter of FY2006.[11]

In Summer 2006 it was reported that the initial batch run had been completed. This was 4 months after completion of the NNSA Readiness Assessment and authorisation to operation. The same report said:

> "Still ahead for this new Y-12 facility is process prove-in, engineering evaluations and production processing".[12]

Progress with the facility was regularly reported in Y12 and NNSA newsletters from 2003 until summer 2006 but there have been no recent newsletter items on these final stages of the project. If the first production batch had been completed it is likely that this would have been reported in these newsletters.

Link to the W76 Life Extension Program

The original 9404-11 building was built in the mid 1970s which is consistent with the manufacture of the W76 warhead.[13]

The NNSA newsletter in November 2003 said:

"The Purification Facility will provide a purification process for manufacturing non-nuclear special materials needed to support the Stockpile Life Extension Program".[14]

The 2005 NNSA evaluation of Y-12 said:

> "Delays in the Purification Facility project, startup and readiness have significantly increased the risk to achieving programmatic target dates"[15]

This report also said that 18 % of the workload associated with the W76-1 LEP had not been completed during the year. This was probably due to the delay with the purification plant.

The 2006 NNSA evaluation of Y-12 said, under the heading W76 LEP –

> "The FY2006 performance measure for this metric included the startup and operation of the Purification Facility and produce initial material, complete

---

[7] Expression of Interest – Purification Facility; 24 October 2002.
[8] Pro2Serve Case Study
[9] Y12 website Decommissioning work.
[10] Pro2serve case study Y-12 Purification Facility
[11] FY2006 Performance and accountability report, US Department of Energy, Status of unmet FY2005 performance targets
[12] http://www.y12.doe.gov/news/report/toc.php?vn=3_2&xml=p14
[13] BWX Tymes November 2002
[14] NNSA Newsletter November / December 2003
[15] NNSA Performance Evaluation of Y-12 2005

DISLEPs, perform some Process Methods Development work, complete the reacceptance testing on certain components and produce some PPI hardware"

It added that the contractor was successful in completing all the base incentive work on the W76-1 LEP.

Recent information on W76 related problems at Y12

On 24 January Frank Munger reported in Knox News:

"Production of replacement parts for W76 warheads remains on hold at Y-12 because of unresolved technical issues, according to a statement released today by federal staff there ..

"Ted Sherry, the NNSA's chief in Oak Ridge, last month indicated that Y-12 was still grappling with the technical issues on the W76, and said a decision would be made in early 2008 whether to proceed or how to proceed.

" 'We have done a lot of up-front work and work on trying to certify that (manufacturing) process, but we have not produced the first production unit' Sherry said"

When Frank Munger asked if the delay was linked to the Purification Facility the response from Steven Wyatt of Y-12 was:

"I simply can't say. I can't say anything more than I've already said. That is the God's truth. What we've said is the limit of what we're going to discuss on this particular issue".[16]

The NNSA Budget for FY 2009 published on 4 February 2008 says –

W76 Life Extension Program -

"Final design of the CSA depends on resolution of a major technical challenge with the production of a critical material. Planned FY2009 workscope is predicated on successful resolution of this technical challenge in FY2008. To ensure a successful resolution in FY2008, NNSA will continue to aggressively work to resolve the material issue and pursue an alternative material study".

"Based upon the resolution of the material issue in FY2008, NNSA will ramp up to full production in FY2009 in accordance with the approved baseline."

Advanced Strategic Computing –

"Recently discovered W76 alternate materials simulation needs are being addressed using ASC codes and are being run on Roadrunner base capacity system. This demonstrates the critical ability of the ASC program codes and computing resources to respond to unanticipated major national security issues".

Enhanced Surveillance -

"Provide new Canned Sub-Assembly (CSA) non-destructive testing capability and material aging analyses to support the ongoing W76-1 design and manufacturing efforts necessary to achieve the First Production Unit"

---

[16] http://blogs.knoxnews.com/knx/munger/2008/01/more_or_less_on_w76.html

The above points show that there is a serious problem with a Special Material and that the NNSA are considering replacing it with an alternative material if they can't get round their manufacturing problems.

It is possible that the problem could be with another Special Material and not Fogbank. However there are several reasons to think that it is –

- there has been a major effort at the plant to build the new Purification Facility for the W76 LEP
- Y-12 is refurbishing the CSAs on the B61 warhead with no reported major problems
- When Y-12 complete the first production batch from the Purification Facility they are likely to publish this, and they have not done so.

Function of the Purification Facility

The old 9404-11 building was "used in a solvent extraction and purification process".[17]

The work carried out in the new facility has been described in the following ways:

"The new Purification Facility will perform processing of a special material using acetonitrile".[18]

"The Purification Facility project is a high priority design/construction effort for a facility that will store and purify a special material".[19]

"The Purification Facility is a complex, hazardous process facility".[20]

"Operations performed within the Purification Production Facility will include: 1) dissolution, filtration, and recrystallization; 2) powder processing in a nitrogen atmosphere, and 3) drying, machining and inspection. The purification process will use flammable liquid acetonitrile (ACN) and will require special design features, including an adjoining tank farm to store ACN"[21]

Fogbank Purification Facility safety

In 2003 a review of the proposed facility pointed out that there were a number of hazards and especially two materials of specific concern.[22] More than 15 safety significant non-nuclear controls had been proposed for the facility. Many of these controls were driven by possible fire or explosion scenarios. Some of the key controls were:

code-stamped vessels and process piping[23]
a nitrogen blanket system
a glove-box sprinkler system
room sprinkler
deluge system

---

[17] Y12 National Security Complex Infrastructure Reduction Contract Buildings 9404-11 and 9767-2; Y12 website.
[18] Defence Nuclear Facilities Safety Board Oak Ridge Weekly Report 9 September 2005
[19] Defence Nuclear Facilities Safety Board Oak Ridge Weekly Report 6 June 2003
[20] Pro2Serve Case Study
[21] NNSA Budget FY 2003
[22] Defence Nuclear Facilities Safety Board Oak Ridge Weekly Report 7 March 2003
[23] Code stamping means that pressure vessels, other vessels and process piping has been approved by the American Society of Mechanical Engineers.

There are concerns about an explosion. The roof is designed with panels that blow out to relief the pressure of an explosion. Because of this the facility does not have a containment or confinement ventilation system.

Processes in the new facility will be housed in gloveboxes.[24]

The hazard evaluation of the facility showed significant non-nuclear off-site effects for some scenarios. There were also concern about the potential impact of accident scenarios on nearby nuclear facilities.[25]

In July 2005 an accident exercise was carried out in the facility. The scenario was that acetonitrile was spilt and this was followed by a fire.

There are Lower Explosive Limit alarms in the facility which monitor for Acetonitrile. In one week in 2006 the facility was evacuated three times when these alarms went off.[26]

A document which details competence required by key workers in the nuclear weapons industry includes the following item:

> "Discuss the nuclear explosive safety implications of the following: LiH and LiD; Fogbank; Beryllium; HU3; Plutonium Hydride."[27]

It is likely that Fogbank is itself a hazardous material. The explosive safety controls in the Purification Facility are more than would normally be required for handling Acetonitrile. This could be due to the amount of Acetonitrile which is involved in the process, or the explosive risk associated with the process.

Studies into Fogbank

1. W76 CSA Evaluation 1995 LANL

> "Evaluation of internal gas generation of a Fogbank in a neutron environment was started in FY95. Reactor tests were carried out, but the year ended before data reduction, evaluation, and reporting could be completed. This contract is for completion of work started".[28]

2. A report in 1996 referred to work on models of warhead materials. The models would be incorporated into new codes under the Accelerated Strategic Computing Initiative (ASCI). The main focus was on the aging of materials. Fogbank was included in the list. The section showing what the particular concerns were with Fogbank was "purposely left blank".[29]

3. Materials Study on Fogbank 1996 LANL

> "In order to predict the stability of the material, a basic understanding of the chemical properties of the material under various processing and storage conditions are required."[30]

4. Characterization and aging studies of fogbank 1999[31]

---

[24] NNSA Newsletter November / December 2003
[25] Defence Nuclear Facilities Safety Board Oak Ridge Weekly Report 7 March 2003
[26] Defence Nuclear Facilities Safety Board Oak Ridge Weekly Report 3 March 2006
[27] https://hss.doe.gov/NuclearSafety/techstds/standard/std1185/std11852004.pdf
[28] DOE Science Accelerator
[29] The Advanced Manufacturing Science and Technology Program FY95 Annual Report, LANL, March 1996.
[30] DOE Science Accelerator.

5. Models of the Aging of Fogbank 2003

> "We continue our assessment of the physical and chemical aspects of the aging of this material and how it could interact with other materials in the Canned Sub-Assembly (CSA). An impurity, which we had previously predicted the existence of, has now been observed, and we are involved in analysing its role in the aging properties".[32]

6. The NNSA budget for FY2005 under Y-12 Science Campaign includes –

> "evaluate effect of proposed process changes on Fogbank material properties"[33]

7. The agenda for a conference in September 2006 lists the topic for one session as "Thoughts on the relationship between Fogbank and its Solvent".[34] There were also other sessions could have been on Fogbank or other special materials. These sessions were on: Outgassing and Reactions of a Special Material; Characterization of a CSA Material; Aging Study of a CSA Material and Microscopy of a CSA Material.

Item 5 above was led by Edward Kober is responsible for Explosives and Organic Chemistry in the Theoretical Division at LANL. The 8 scientists responsible for item 4 work in different branches of LANL, as is normal for LANL reports. The predominant expertise of those listed is in organic chemistry and explosives, with some having expertise in metallurgy. Thomas Larson, who is quoted below, began work at LANL as an explosives expert. In his statement, before he referred to Fogbank, he pointed out that he had made significant contributions to areas of work other than explosives.

Other comments on Fogbank

Thomas Larson, who worked at LANL from 1956 said:

> "[I] also worked with another classified material that we call Fogbank ... that's an unclassified name for it".[35]

James David Mason, a senior member of staff at Y12, was unofficially quoted in August 2007 as saying:

> "They're starting to make things with Fogbank again after many years of not using it, and it's a big concern".[36]

Fogbank and the UK nuclear weapons programme

The new purification facility is the only place where Fogbank is manufactured. Cindy Hayes, Director of Modernization at Y-12 said:

> "the material produced by this project is considered special because no one else other than Y-12 makes it".[37]

---

[31] Characterization and aging studies of fogbank 1999, LL Wang et al, LANL; Listed on LANL Library Catalogue.
[32] Theoretical Division Activities in Support of the Nuclear Weapons Program 2003/04 LANL
[33] NNSA budget FY 2005
[34] CASS 2006 agenda 27/9/2006
[35] http://www.complex2030peis.com/12-06-2006%201213%20Wednesday.pdf
[36] http://recycledknowledge.blogspot.com/2007/08/extreme-markup-2007-thursday.html
[37] BWX Tymes 4 April 2002

Fogbank is a critical component of the Trident W76 warhead. The design margins of the W76 warhead are so tight that it is unlikely that AWE could produce an alternative secondary with a different design that would fit the constraints of the Mk4 Re-entry Vehicle. The UK warhead is officially described as an "Anglicised version" of the US warhead. So it is almost certain that the UK warhead will contain Fogbank and that the US has supplied Fogbank material to AWE.

Role of Fogbank in the warhead

The term Fogbank could be a random code word. However if the name does relate to its function then it could be material which plays some part in the channelling of x-ray radiation from the primary to the spark-plug in the secondary.

It is possible that Fogbank is only used on only some of the warheads currently in service. The W76 is a relatively small and light warhead. It is known that one of its unique features is that it has a thinner radiation case than other warheads. It is possible that the requirement for Fogbank is linked to this.

Seabreeze and other special materials

In 2001 the NNSA were planning to build a new Special Materials Complex. The project was scaled down and the only part of it that was built was a Purification Facilty. However the original proposal for the Special Materials Complex had included:

> "A Seabreeze and Diallyl Phthalate (DAP) production area – The current production equipment for these materials has deteriorated to the point that operational reliability and worker protection cannot be assured."[38]

An Environmental Impact Statement for Y-12 said:

> "*Special Materials.* Special materials such as Diallyl Phthalate are required to support the lithium processes."[39]

Similar code words are often used in the nuclear weapons industry. For example in 1961 the US Atomic Energy Commission referred to Plutonium 238 as Wine and Neptunium 237 as Brandy.[40]

Seabreeze could be:

- A material used to process Lithium
- A material used in the CSA of the warhead, possibly related to Fogbank
- A material used in the production of Fogbank

John Ainslie, Scottish CND, 9 February 2008

---

[38] NNSA Budget Supplement FY2001
[39] DOE/EIS-0236 Final Programmatic Environmental Impact Statement for Stockpile Stewardship
[40]. http://www.osti.gov/bridge/servlets/purl/10177563-9EFFFy/native/10177563.PDF