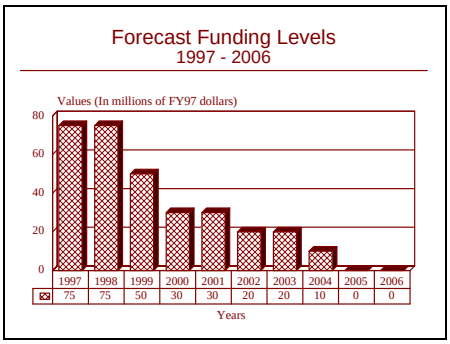
# IUKADGE - Archived 4/98

## Outlook

- System delivered six years late
- UK planning to replace IUKADGE with another system around the year 2003
- Numerous operational shortfalls remain
- Industrial support being negotiated




## Orientation

Description. A broad-based air defense command and control system using existing commercial software, System X telephone systems and Marconi/GE/Plessey radars tasked with the operation of UK air defenses.

### Sponsor

Contracts Branch CB/SLS31b
Ministry of Defense
Room 630
St. Georges Court
New Oxford Street
London WC1A 1EJ
United Kingdom
Tel: +441 637 3633

### Contractors

Ferranti Computer Systems Ltd
Western Road
Bracknell
Berkshire RG12 1RA
United Kingdom
Tel: +44 344 483232

British Aerospace
Military Aircraft Division
Wharton Aerodrome
Preston
Lancashire PR4 2AX
United Kingdom
Tel +44 772 633333

GEC-Marconi Radar Systems
Writtle Road
Chelmsford
Essex CM1 3BN
United Kingdom
Tel: +44 245 267111

Siemens-Plessey Radar Ltd
Oakcroft Road
Chessington
Surrey
United Kingdom
Tel: +44 81 397 5171

Lockheed Martin Corporation
Electronics Sector
(formerly General Electric Company
Electronics Systems Division)
6801 Rockledge Drive
Bethesda, Maryland (MD) 20817
USA
Tel: +1 301 897 6000
Fax: +1 301 897 6654

IUKADGE radars are supplied by Marconi Radar Systems, Plessey Radar and the former General Electric Company (now Lockheed Martin Corp). Data linking is supplied by Ferranti Computer Systems Ltd.

Licensee. No production licenses have been granted.

Status. Procurement and modification.

Total Produced. IUKADGE is a single integrated system consisting of 12 radars and a number of operational centers.

Application. IUKADGE was intended to provide adequate surveillance, command and control over the UK Air Defense Region and provide adequate defensive capabilities within that region.

Price Range. Price range for the Martello S723 has varied between approximately US$8 million and US$10 million. No information on the Martello S713 is available, but the unit cost is unlikely to differ drastically. The AR-320 is priced at US$10 million in 1984 economy. The TPS-59 was priced at US$12.6 million in FY83 prices.

# Technical Data

Design Features. A hardened Air Defense Operations Centre at High Wycombe and an alternate ADOC at Bentley Priory will receive and analyze data from land and airborne early warning radars. The Uniter communications system supplied by GEC Telecommunications is based on the System X digital telephone system developed by Plessey Systems and commercially available software. The backbone of the system is a primary trunk network based on primary trunk switches interconnected by military and civilian landlines and microwave links. The latter were supplied by Thorn-EMI. A stage-two development will upgrade voice communications and increase networking facilities. The ICCS communications system, designed to link the command centers with ground and air sensors, is programmed in a cocktail of three computer languages, CORAL, FORTRAN and RTL-2. A subsequent effort will be required to rewrite this programming in ADA due to compatibility problems that have emerged in the original software.

Operational Characteristics. Radars include the General Electric/Lockheed Martin TPS-592, the Marconi Martello S713 and the Plessey AR-320. Airborne early warning facilities are provided by the US-designed Boeing Sentry AEW.1 system.

# Variants/Upgrades

Four programs were anticipated for the 1990s. The first is the interface with UKAIR CCIS. This system will link Strike Command headquarters with every USAF and RAF base in the UK. This will be followed by integration with the Maritime CCIS, which will benefit considerably from the data obtained by IUKADGE, and permit better integration of the fleet AAW capability with the resources available from land. Smaller programs will integrate IUKADGE with the civilian air traffic control system.

STA(A) 906 was used as the vehicle for introducing new sensor technologies within the ICCS. These include the NATO Identification System and the use of over-the-horizon (OTH) radars such as the FPS-118. The introduction of the latter technology would almost certainly be the result of a collaborative venture with the USA.

The operational side will see the proposed European Fighter Aircraft supplanting the Tornado F.3 in the interceptor role from about the year 2000. The Bloodhound SAM system has now been withdrawn from service and the projected new-generation missile defense system has been abandoned

The UK announced in mid-1996 that it is planning on replacing the existing IUKADGE system with a more modern $C^2$ system tentatively dubbed the Staff Requirement (Air)1303. The new system will be designed to bring the RAF up to speed technology-wise and give them a head-start in winning the race to digitization. SR(A)1303 could conceivably be taken on-line as early as 2003.

# Program Review

Background. The UK Air Defense Region is responsible for more than four million square miles of airspace. Adequate command and control of this area has been severely hampered by years of low priority and inadequate funding. The Linesman-Mediator system intended to meet this role was never completed. Those parts of the system that were functioning became obsolete with the introduction of NATO's flexible response strategy. This effectively changed the UK from a nuclear launch pad to a strategic staging post.

These technical shortcomings were compounded by an accelerating threat mounted by Soviet long-range aviation. The frequency of interceptions along the Northern edges of the region increased steadily until 1980, when it reached five per week. In spite of this, the numbers of interceptors available declined steadily, and the communications systems remained soft and vulnerable.

In 1971 the decision was taken to expand, reorganize and upgrade the Linesman system. The UKADGE was conceived as a stop-gap measure until a more comprehensive modernization program could be undertaken. This culminated in the inception of the IUKADGE programs.

The core of IUKADGE is the Improved Command and Control System (ICCS) which was defined by ASR.888. The contracts for this were awarded to a multinational consortium, UKADGE Systems Ltd (UKSL), in 1980 and formally signed in 1981. This was designed to be the largest software-based communications system in Europe, linking British and allied land-based sensors, operational sites, aircraft and warships with command and control sites.

The primary sensors for IUKADGE are land-based microwave radars; they are transportable in the interests of flexibility and survivability. Radar selection was dictated by the desire to have a wide range of operating frequencies (D to F band). This is essential in order to improve coverage and provide broader and more difficult ECM targets.

In common with the rest of the IUKADGE system, the radars have been beset by technical, political and managerial problems. It took five years to ensure that the TPS-592 radars met full operational requirements. Political problems surrounded the selection of the E-F band systems required to meet ASR.1585 in 1981-82. Although the Marconi Martello system selection was problem-free, the competition between the Plessey AR-320 and the Hughes HADR resulted in several months of political deadlock. After this problem was resolved, the four Marconi radars were delivered in 1986, with the six AR-320s to follow in 1988/89.

The decision to add a passive component to the detection system was reached in 1987. This was intended to force attacking aircraft to adopt great restraint in using their radar systems, as well as rendering the active radar stations less vulnerable to attack. At the time of this writing, no request for proposals has been issued in this respect, nor has funding been allocated.

The cumulative effects of the problems plaguing the IUKADGE system pushed the whole program back and resulted in a bow-wave of corrective and substitutive programs. Of these, the substitution of the Boeing Sentry AEW.1 for the Nimrod AEW, the serious delays and problems with the Foxhunter radars on Tornado F.3, and the problems with TPS-592 are most publicized. By 1988, the program was running at least 18 months behind schedule and overall program slippage had increased to two years by the middle of 1989. By early 1991 the delays had increased to seven years.

The scheduled September 1988 hand-over of the ICCS system to the RAF failed to take place on schedule. The UK MoD stated that further slippage had taken place due to difficulties in the integration testing of the complete system. Spokesman for one of the consortium members said that ICCS was currently in the pre-technical transfer phase. By late 1988 it was reported that the system fell far short of its operational requirements and would not be in service until mid-1992. The UKSL denied this and indicated that, in their opinion, ICCS would be ready for hand-over during 1990.

In April 1989 the UK Ministry of Defence abandoned plans to introduce the ICCS segment of IUKADGE into service during 1989 due to continuous technical difficulties. Full operational capability of this essential part of the system was not then expected until 1992, five years later than originally planned. The substantial added costs resulting from this delay were absorbed by the UKSL consortium. The problems centered on debugging the software and getting the programs to run together. The difficulties were compounded by the fact that the firms working on the project used different software languages (i.e. CORAL, FORTRAN and RTL-2), with resulting compatibility problems. As a result, the UK MoD started investigating the possibility of redeveloping the system software in ADA. This was found to be an extremely expensive operation and is likely to take place only as part of the midlife upgrade scheduled for the late 1990s.

In April 1989 the Royal Air Force began introduction of its Permanent War Headquarters (PWHQ) into service at its Strike Command HQ in High Wycombe. The bunker complex, known as Broad Shield, replaced the previous Regional Air Operations Centre built in 1938. Broad Shield will also act as NATO's main war headquarters for the UK Air Defense Region.

That October, the Royal Air Force announced its decision to equip its tanker aircraft, Sentry AEW.1 and Tornado F.3 forces with the Link-16 JTIDS system. The tanker aircraft are intended to act as relay stations for the Tornado and Sentry aircraft supplementing ground- and sea-based systems. A major problem arising from this decision is the inability of the existing IUKADGE communications system to cope with the message volume requirements for JTIDS. The UK Ministry of Defense is exmining a number of options for coping with this problem. However, an examination of the problem indicates that the additional bolt- on computing power with the required

discrete operating network will delay full IUKADGE/Link-16 compatibility to 2005 at a cost of around US$49 million. The acceptability of this impact has been questioned.

By June 1989 the delays and performance shortfalls afflicting IUKADGE had reached the point where the MoD was examining alternative ways of meeting the requirements. Plessey, Ferranti and Thorn-EMI were all awarded contracts under the TRIAD (Techniques for Realizing an Integrated Air Defense) system. These awards were for the evaluation of techniques by which bulk processing ability could be added to the existing ICCS architecture via an MoD-owned public interface. This program was described as a quick fix taking (the program) to the end of the century. Further work on this option is considered necessary by all the companies involved.

Another option for solving ICCS's deep-rooted problems involved scrapping the existing system and starting over. This would have involved writing off over US$600 million then expended on ICCS to date. It was pointed out that while the costs involved in such a step would be politically embarrassing, they would not be significantly greater than those of redeveloping the entire system in ADA and running it on new computers.

On the bonus side, the deliveries of Sentry AEW.1 aircraft were completed on schedule. The first Sentry aircraft arrived at RAF Waddington on July 4, 1990 (a month ahead of schedule), with final deliveries in March 1992. The Sentry AEW.1 replaced the existing Shackleton force in June 1991. Suggestions that reduced Soviet threat levels might require fewer than the seven originally planned aircraft were refuted on operational grounds, and on the fact that they composed the only effective air defense command/control system in UK airspace. The current force consists of six aircraft in service and one in storage as an attrition replacement.

While the Sentry AEW.1 was entering service, successful trials of some elements of the IUKADGE/ICCS system were carried out. These focused on the Sector Operations Center (SOC) at Buchan in Scotland, the closest of the four SOCs to full operational capacity. All four centers are fully equipped and capable of stand-alone operation. Key problems emerged when attempts were made to network the four stations. The resulting system was very fragile. When networking two or more SOCs was attempted, problems caused an almost immediate crash. The cause was subsequently identified as self-flooding, whereby messages between the centers would be repeated unnecessarily until the system crashed. Further experimental work increased stability at the SOC level.

By the middle of 1991 there was growing confidence in the UK MoD that the five-year history of stability and data integrity problems had finally been resolved. Trials linking the operating centers to the command reporting posts were finally successful and a full-scale trial involving all four SOCs was scheduled. For the first time, the UK MoD felt confident that the system would meet the requirements originally laid down. Following this trial the ICCS system was formally handed over to the RAF on September 27, 1991.

Over the next year, an increasing number of the command and reporting posts and centers were brought up to a fully operational standard, while other sites were at a stage where they could be used for training purposes or further development work. This included a soak test using the entire system. Computer language compatibility problems were resolved with the establishment of a common standard for data entry across the entire network. The ICCS software was delivered in September 1992; warranty work was expected to stretch several years beyond.

In January 1993, another long-running problem area was confronted when the UK MoD issued invitations to tender for the supply of two long-range mobile air defense radars. Companies invited to bid for this requirement, SRA.918, included Marconi Radar Systems, Siemens-Plessey, Alenia, Thomson-CSF, TST, General Electric and Westinghouse. The selected radars were to replace the TPS-592 systems. This contract was awarded in January 1994 to Siemens-Plessey and involved the supply of three AR-327 radars.

The IUKADGE system entered formal operation in June 1993, six years behind schedule. MoD officials attribute the final success of the program solely to Nancy Price, then head of UKSL and now vice president at Hughes and in charge of the Canadian ATC program. Sources at the UK MoD have specifically stated that it was only her ability to pull the project management team together that saved the program from cancellation. In 1994 Hughes received a major international award for achievement in military aviation for its work on IUKADGE. With the system up and running, trials were started on the inclusion of JTIDS tactical linking and incorporation of information from Royal Navy warships off the British coast.

As the existing IUKADGE system was brought on line, UKSL and the UK MoD opened talks on the future industrial support of the system. The options under evaluation included maintaining the existing UKSL Consortium to undertake the necessary support functions, or allowing the three members to go their own way and compete against each other for maintenance and upgrade contracts. Consortium members are reported to have proposed a modified version of the existing arrangements, while the MoD is unwilling to continue with consortia-based proposals following the extremely unsatisfactory management relations that existed prior to the arrival of Nancy Price.

## Funding

A total of US$1.6 billion has been spent on the elements of the IUKADGE system. The original ICCS contract was valued at US$240 million, subsequently increasing to US$272 million, while the radars cost a total of US$192 million (120 million pounds). The communications sections of the system are worth US$464 million. It is reported that over half the total expenditure will be recovered from NATO infrastructure funds. These also provided 80 percent of the costs of the radars.

British government statements indicate that the total estimated expenditure on the ICCS component to the end of 1990-1991 was US$523 million. However, comparable figures for 1987-1988 expenditure on ICCS amounted to US$680 million with US$120 million for associated work. This strongly suggests that at least one set of figures quoted is misleading. Possibly as a result of this discrepancy, no funding information on the IUKADGE program was included in the 1992 Defence Estimates or the House of Commons Defence Committee report thereon. In subsequent British Government statements, IUKADGE was listed as having been delivered in 1993 and, therefore, was not included in future costings.

## Recent Contracts

| Contractor | Award ($ millions) | Date/Description |
|---|---|---|
| Siemens-Plessey | 34.0 | Jan 1994 — UK MoD contract for three AR-327 tactical radars for addition to the IUKADGE network |

* No major contracts more recent than January 1994 have been identified for this program.

## Timetable

| | |
|---|---|
| 1971 | MoD decided on Linesman upgrade |
| 1972 | Decision to initiate IUKADGE |
| 1979 | Staff requirements formulated |
| 1980 | ICCS contract awarded |
| 1981 | ICCS contract signed |
| 1982 | Communications installations started |
| | TPS-592 radars delivered |
| | Orders signed for Marconi radars |
| 1984 | Acceptance of TPS 592 radars |
| 1986 | Delivery of Marconi radars started |
| | Completion of communications systems |
| | Decision to include passive detection stations |
| | GEC contract for phase 2 of communications |
| | Boeing E-3 ordered as Sentry AEW-1 |
| 1987 | Orders placed for UKAIR system |
| | TPS radars operational |
| 1988 | BAE contract for interoperability tests |
| | Delivery of Plessey AR-320 radars started |
| | Communications integrity tests by Ferranti |
| 1989 | ICCS stations handed over for test |
| | High Wycombe PWHQ delivered |

| | | |
|---|---|---|
| | 1990 | Installation of JTIDS systems interface |
| Jul | 1990 | Boeing Sentry AEW-1 delivered to RAF |
| Jul | 1991 | Sentry AEW.1 operational |
| Sep | | ICCS system handover |
| Jan | 1993 | Bids for TPS-592 replacement invited |
| | 1994 | AR-327 radars chosen to replace TPS-592 |
| | | Scheduled IUKADGE/ICCS system completion |
| Jun | 1996 | Announcement that IUKADGE would be replaced by a more modern and efficient system |
| | 1998 | JFAC component of replacement system scheduled to be online |
| | 2003 | Replacement for IUKADGE may be fully operational |

## Worldwide Distribution

IUKADGE is a system specifically tailored for the one purpose of guarding **UK** airspace. It is, therefore, only deployed within the UK and has no export prospects as a system, although its individual components can, and have, achieved export successes.

## Forecast Rationale

The IUKADGE program has been practically a case study of the problems that can occur when a sophisticated program is launched without the benefit of an independent supervisory authority and without fully defining the technological requirements for the system. Despite the fact that the RAF was given control of the ICCS system in September 1991, the system did not reach full operational capability until June 1993.

Following a long history of delays and problems with the program, the UK announced, in July 1996, that it was planning to replace the aging IUKADGE with a more current system designed to give the Royal Air Force an edge in modern digital warfare. Designated Staff Requirement (Air) 1303 [or SR(A)1303], the new system will comprise an extremely efficient ACCS system, Joint Force Air Component (JFAC) headquarters, and a Tactical Air Control Center (TACC).

These components would, of course, evolve into a single system and work seamlessly in conjunction with one another. A tentative date of 2003+ has been mentioned for when the full system could be brought on line. The JFAC component may be up and running as soon as 1998.

In the meantime, IUKADGE will still receive a steady flow of contracts for maintenance, interoperability testing and enhancements. The scheduled annual costs of the system should decrease through the rest of the forecast period, if the system remains in operation throughout that time.

## Ten-Year Outlook

DROP REPORT