PURCHASE OF GLASS LASERS FOR PART 1 OF THE JOINT LASER CENTRE CAPITAL PROGRAMME

In the first part of the establishment of the JLC, two glass lasers are to be provided. The smaller is a laser of medium energy, 10 joules will be radiated in a single pulse with a full width at half maximum intensity of 100 picoseconds. The 'large laser' will have two beams each of which will radiate 250 joules in a single pulse with a full width at half maximum intensity of 300 picoseconds.

In order to identify possible suppliers of the required equipment an exhaustive survey of companies in Britain, Europe and the United States has been made. The possible suppliers are listed below:

UK	- FERRANTI LTD
	- J K LASERS LTD
EUROPE	- CILAS
	- QUANTEL
USA	- APOLLO LASERS
	- GENERAL ELECTRIC CORP
	- HADRON
	- RAYTHEON

Of these companies only one, The General Electric Corporation, has demonstrated a capability to design construct and commission a high power laser of the size required to meet the specification of the JLC - 'large laser'. In order therefore to ensure the maximum possible competition at the Tender stage the hardware requirements for the 'large laser' have been split into two parts. The first part will take the energy to ~30 joules and is very similar to the 10 joules medium energy laser, the second part includes the split into two beams and is wholly composed of high energy laser amplifiers of the kind developed by General Electric.

It is proposed that tenders should be invited against three specifications.

1. Two 10 joule/100ps Neodymium glass lasers - one to be the medium energy stand alone facility, one to be a driver for the 2 x 250 joule system.

2. A Neodymium glass laser amplifier to have an input energy of ~30 joules in 300ps and to have two output beams each of 250 joule energy.

3. A complete high power Neodymium glass laser system delivering 500 joules in 300ps in two beams.

Ferranti Limited J K Lasers Limited and Apollo Inc. have indicated verbally that they would not be able to manufacture any of the lasers described above. Hadron is effectively a US Agent for CILAS and RAYTHEON have little experience in high power laser design, they have constructed components for KMSF and University of Rochester to the customers designs; this leaves Quantel, Cilas and General Electric Corp. to bid for the construction of item 1 above. It is believed that only General Electric could meet the specifications outlined in 2 and 3 at the time when the contract would be placed.

On this basis, instructions to the contracts branch to seek tenders for the supply of glass lasers for the JLC have been prepared. These are attached to this paper as Annexes 1 to 3.

Single tender action is suggested for item 2 above and is justified in Annex 4.

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30th January 1975

SPECIFICATION NO. 1

A Medium power neodymium glass laser system

Neodymium glass laser system to deliver an energy of 10 joules in an approximately Gaussian pulse with a full width of 100 picoseconds at the half maximum intensity level (fwhm).

The laser will be used to produce a high intensity focal spot on a reflecting target and must be protected by suitable isolators against retro-reflection of 30% of the incident energy.

Beam quality is of utmost importance and the intensity x length integral must be minimised to ensure that not less than 90% of the radiated energy in a collimated beam is contained in a 0.5 milli-radian full angle cone. The beam quality will be measured by focussing the output of the final laser stage, using a lens of 10m focal length, onto an aperture 5mm in diameter. 90% of the radiated energy will be required to enter the aperture.

The repetition rate must not be less than one pulse per 10 minutes, the capacitor bank charging time must not be greater than 1 minute. The laser must be provided with a single mode TEM_{oo} oscillator capable of providing pulses with adjustment in the range fwhm 30 picoseconds to 5 nanoseconds. The stability of the oscillator shall ensure that in 100 consecutive pulses the energy in a single pulse shall not deviate by more than 15% from the mean value under the standard operating conditions.

The system must have a high contrast ratio; energy emitted before the main pulse, and which is contained within the 0.5 mr full angle cone defined above, must not exceed 1×10^{-5} times the energy in the main pulse.

The equipment supplied should include all necessary benches, supports, cooling and control systems needed to operate the laser system.

Delivery, installation and commissioning costs should be quoted separately. The cost of an itemised list of recommended spares should be quoted separately.

SPECIFICATION NO. 2

A high power medium energy laser system

Neodymium glass laser system to deliver an energy of 500 joules in two beams in an approximately Gaussian pulse with a full width of 300 picoseconds at the half maximum intensity level (fwhm).

The laser will be used to produce a high intensity focal spot on a reflecting target and must be protected by suitable isolators against retro-reflection of 30% of the incident energy.

Beam quality is of utmost importance and the intensity x length integral must be minimised to ensure that not less than 70% of the radiated energy in a collimated beam is contained in a 0.5 milli-radian full angle cone. The beam quality will be measured using a plane beam splitter to deflect a small fraction (e.g. about 5%) of the output of the final laser state and by focussing this fraction with a 10m focal length lens onto a circular aperture 5 mm in diameter. 70% of the energy of this deflected beam will be required to enter this aperture.

The repetition rate must not be less than one pulse per 20 minutes, the capacitor bank charging time must not be greater than 3 minutes. The laser must be provided with a single mode TEM_{oo} oscillator capable of providing pulses with adjustment in the range fwhm 30 picoseconds to 5 nanoseconds. The stability of the oscillator shall ensure that for 100 consecutive pulses the energy in any single pulse shall not deviate more than 15% from the mean value under the standard operating conditions.

The energy radiated by the laser into the 0.5 mr full angle cone and before the main pulse must not exceed 1×10^{-5} times that in the main pulse.

The equipment supplied should include all necessary cooling and control systems needed to operate the laser system.

Delivery installation and commissioning costs should be quoted separately. The cost of an itemised list of recommended spares should be quoted separately.

SPECIFICATION NO. 3

A high power laser amplifier

Neodymium glass laser system consisting of only that part of the system described in Spec. 2 after the last Neodymium rod amplifier. The output is to be as specified in Spec. 2, the input to be specified by the supplier but capable of being delivered by a laser conforming to the specification in Spec. 1 with an appropriate setting of the oscillator pulse width. The electrical and optical interface at the input of this amplifier to be the responsibility of the purchaser.

Delivery installation and commissioning costs should be quoted separately. The cost of an itemised list of recommended spares should be quoted separately.

SINGLE TENDER ACTION FOR THE SUPPLY OF A 1.5TW, 500 JOULE NEODYMIUM GLASS LASER SYSTEM

The principal laser in the UKAEA/SRC Joint Laser Centre will be a high power neodymium glass laser for use in the study of high density plasmas. The specification of the laser puts it at the frontier of the present state of development of these devices. Lasers of comparable specification exist in the United States at Lawrence Livermore Laboratory, Los Alamos Scientific Laboratory, The University of Rochester and KMS Fusion Inc. In the first three cases cited above, the laser is of 'in house' construction; the high power components of the laser at KMSF were constructed by the General Electric Corporation of America. This company is the only company in the world that has demonstrated a capability to design, construct and install high energy laser systems capable of producing powers in the region of 1 Terawatt. A careful investigation of companies that might in the future be able to meet the specification, i.e., CILAS, and QUANTEL (both French companies) confirms that although these companies could supply the low power components (<200GW) of the system, they are unable to supply field-proven equipment to meet the specification. No alternative therefore exists to proceeding to invite a single tender from the General Electric Corporation for the supply of the high power components for this laser.

Preliminary discussions with General Electric Corp officials have revealed that they would be willing to negotiate to purchase components for the system in the United Kingdom where this would offer a financial or logistic advantage. The possibility of obtaining the main 2Mjoule energy storage capacitor bank in Britain has been investigated but, at present prices, this appears to be financially unattractive;

GE price	£66,000
In-house manufacture	
BICC price	£95,000
UK manufacture:	
Dubilier price	£208,000
UK manufacture	

Some components such as the capacitor mounting frames, the laser support system, cables and electrical hardware could be obtained and paid for in the UK.