CNC LASER MACHINE
WITH SHUTTLE-TABLE

FO SERIES (US)

(FS-160iLA)

OPERATOR'S MANUAL

ΩMADA

PREFACE Read this manual carefully to obtain a thorough knowledge of the machine operation and maintenance. Be sure to follow the instructions to ensure proper procedures and prevent injuries and accidents. Do not operate the machine by guesswork — keep the manual at hand and refer to it whenever you are not sure of how to perform any of the procedures.

NOTE

● For the descriptions of the shuttle table, the cooling unit, the dust collector unit, and programming, refer to their respective manuals.

RECEPTION We have loaded your machine onto a carrier's truck and it was recognized as being dispatched in perfect condition.

However, in the event of an incident during shipping (always possible), or if you observe any visible damage (signs of shock or impact, etc.) on your machine, please remember to make your reservations in the following manner:

A — On the delivery form which will be submitted to you for acceptance by the carrier

B — By indicating them to the carrier and to ourselves (for simple information) by registered letter within 48 hours at the latest.

Printed in Japan

CONTENTS

(Continued on next page.)

HS Cooling Cutting

Cutting Precautions

● The cutting conditions and piercing conditions must be finely adjusted, depending on the condition of the mirrors or lens.   Lower the cutting feed rate or raise the pulse duty for gouging during cutting.   Extend the piercing time or raise the pulse duty when the hole is not pierced through the worksheet.

● The maximum cutting feed rate for cutting a round hole is 150 times the diameter of the hole.   The roundness of the hole deteriorates when the hole is cut at a higher feed rate.

● When cutting a hole by using a pre-registered processing condition file, use a cutting condition of decreasing number with decreasing hole diameter.

● The minimum diameter of the hole to be cut is the same as the thickness of the worksheet to be used.

● Worksheets may not be properly cut, depending on their material or surface condition (whether or not rust, oil, or scale is deposited).

● When a worksheet protected with a vinyl sheet (especially polyvinyl chloride sheet) is cut, the gas generated during the cutting operation corrodes the machine.   Apply a rust inhibitor to the machine.

● When a worksheet with its top surface protected with a vinyl sheet is cut, the protective sheet may be removed by the discharge of the assist gas and interfere with the cutting of the worksheet.

● When an aluminum worksheet is cut with its vinyl sheet-protected surface facing down, the adhesion of dross on the bottom of the cut can be reduced.

● Before ordinary cutting (oxygen cutting) of stainless steel, apply a dross adhesion inhibitor to the worksheet to facilitate the removal of dross from the cut.

Safety Rules

Observe these safety rules to prevent injuries and accidents.

Installing the machine:

a) Refer to the separate installation manual.

Laser cutting:

b) Wear the goggles properly designed to protect your eyes during laser cutting. The direct or reflected, invisible CO_2 laser beam can seriously injure your eyes.

c) Wear the clothing that is nonflammable and exposes less part of your body to protect you against burning by the spatters caused during laser cutting.

d) Never cut plywood boards, organic compounds, or other materials that may catch fire or produce toxic gases when the materials are exposed to the CO_2 laser beam. Doing so will disrupt the safety of the operator and the machine.

e) Don't fail to ventilate the shop — synthetic or coated materials produce harmful fumes during laser cutting.

f) Don't place flammable materials around the machine. Sparks may fly and ignite any flammable materials nearby.

g) In normal operation, the metallic particles from aluminum and alloyed material tend to stick in the dust collector and induction duct.
To avoid explosions, one should check and ensure cleanliness of these every day before starting up the machine.

h) Stop the machine and remove the scrap from the table as soon as one process of cutting the flammable material is finished — to prevent the scrap from being set on fire.   To work inside the hazardous area, don't fail to observe the rules described under "Working inside the hazardous area" — *see below.*

i) Don't touch the surfaces of the laser lens and oscillator inside mirrors, which are made of toxic materials*, nor inhale the vapors generated when the toxic materials are burned.   When discarding the lens and mirrors, consult a waste disposal contractor.
* Zinc selenide; for more information, refer to the Appendix.

j) Have your eyes thoroughly examined regularly — immediately if you suspect of a disorder that might have been caused by the harmful CO_2 laser beam.

Operating the machine:

k) Have the machine operated by a single, trained person who has read this manual and acquired a thorough knowledge of the machine and its operation.   If more than one authorized operator must be involved, coordinate their work to ensure utmost safety.

l) Clear the hazardous area around the machine of people and obstacles before starting the machine — don't fail to check the area behind the machine.

m) Make it a rule to stay out of the hazardous area when the machine is being operated.   If you must work inside the area, don't fail to observe the rules described under "Working inside the hazardous area" — *see below.*

n) Don't open the laser oscillator or the electrical control unit when the power is on — they have a deadly high voltage inside.

o) Don't leave the keys in the machine's keyswitches.   Keep the keys in the custody of the supervisor when they are not in use.

p) When you wear a pacemaker or similar electronic medical device, don't approach the machine.   The device may malfunction or fail due to the electromagnetic waves from the machine.

q) Do not place a worksheet projecting from the table.   A worksheet loaded projecting from the table may strike the carriage or fall from the table.   Do not stand the worksheet against the laser cutting machine either.

Working inside the hazardous area:

r) Check to ensure that the machine is stopped.

s) Press the STOP buttons on the CNC control panel and the shuttle table control panel — to prevent the machine to be started inadvertently.

t) Turn the SHUTTER keyswitch to OFF, remove the key from the switch, and hold it by yourself — to prevent erroneous CO_2 laser beam emission.

u) Never place your hand under the laser head — extremely dangerous if the CO_2 laser beam is emitted in error.

Servicing the machine:

v) Turn off the machine and laser oscillator circuit breaker switches, the supply of compressed air, and then the shop circuit breaker switch during an inspection or maintenance work.   Then padlock the machine and laser oscillator circuit breaker switch levers and the air intake valve at the air system.   If the work must be performed inside the hazardous area, also observe the rules described under "Working inside the hazardous area" — *see above.*

w) Post a sign to inform people that the machine is being serviced.

x) Never modify the machine's parts or electric circuits or change them with unauthorized parts or circuits.   Doing so will cause machine disorders and damages and disrupt the safety of the machine and the operator.

DANGER and WARNING plates

Keep the DANGER and WARNING plates well noticeable and never remove them.

CAUTION-
LASER RADIATION WHEN
OPEN AND INTERLOCKS
DEFEATED. AVOID EYE
OR SKIN EXPOSURE TO
DIRECT OR SCATTERED
RADIATION.

AVOID EXPOSURE-
VISIBLE AND/OR INVISIBLE LASER RADIATION
IS EMITTED FROM THIS APERTURE.

⚠DANGER

⚠DANGER

Pinch Point

⚠DANGER

⚠DANGER

⚠DANGER

5 bend mirrors

CAUTION-LASER RADIATION WHEN OPEN
AND INTERLOCKS DEFEATED.
AVOID EYE OR SKIN EXPOSURE
TO DIRECT OR SCATTERED
RADIATION.

Pinch Point

⚠DANGER

Hazard seriousness level

⚠ **DANGER** Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

⚠ **WARNING** Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

⚠ **CAUTION** Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

-INVISIBLE and/or VISIBLE LASER RADIATION-
AVOID EYE OR SKIN EXPOSURE TO DIRECT OR
SCATTERED RADIATION.
-RAYONNEMENT LASER INVISIBLE ET/OU VISIBLE-
EVITER TOUT CONTACT DES YEUX OU DE LA PEAU AVEC
LES RAYONNEMENTS DIRECTS OU REFLECHIS.

		INVISIBLE/INVISIBLE VISIBLE/VISIBLE	
		IEC 825-1:1993	
LASER	/ LASER	CLASS 4/CLASSE 4	CLASS 3A/CLASSE 3A
MAXIMUM POWER	/ PUISSANCE MAXI	3500W	<5mW
PULSE DURATION	/ DUREE IMPULSION	100P·CW	CW
EMITTED WAVELENGTH	/ LONGUEUR D'ONDE EMISE	10.6Pm	0.6-0.7Pm
LASER MEDIUM	/ COMPOSITION GAZ LASER CO₂/N₂/He=4/36/60%	SEMICON. or HeNe	HeNe

-SICHTBARE U/O UNSICHTBARE LASERSTRAHLUNG-
BESTRAHLUNG VON AUGE ODER HAUT DURCH
DIREKTE ODER STREUSTRAHLUNG VERMEIDEN.
-RADIAZIONE LASER INVISIBILE E/O VISIBILE-
EVITARE L'ESPOSIZIONE DEGLI OCCHI O DELLA PELLE
ALLA RADIAZIONE DIRETTA O DIFFUSA.

		INVISIBLE/INVISIBILE SICHTBARE/VISIBILE	
		IEC 825-1:1993	
LASER	/ PROMOTED LASER	KLASSE 4/CLASSE 4	KLASSE 3A/CLASSE 3A
ANZEIG. d LASER / STRAH/ EMISSIONE MASSIMA		3500W	<5mW
PULSDAUER	/ DURATA IMPULSO	100P·CW	CW
WELLENLANGE	/ LUNGHEZZA D'ONDA NETT/MMD	10.6Pm	0.6-0.7Pm
LASERMEDIUM	/ MISCELA GAS DEL LASER CO₂/N₂/He=4/36/60%	HALBLEITER u. HeNe	SEMICON. u HeNe

CAUTION-LASER RADIATION WHEN OPEN.
AVOID EYE OR SKIN EXPOSURE
TO DIRECT OR SCATTERED
RADIATION.

⚠ DANGER
Pinch
Point
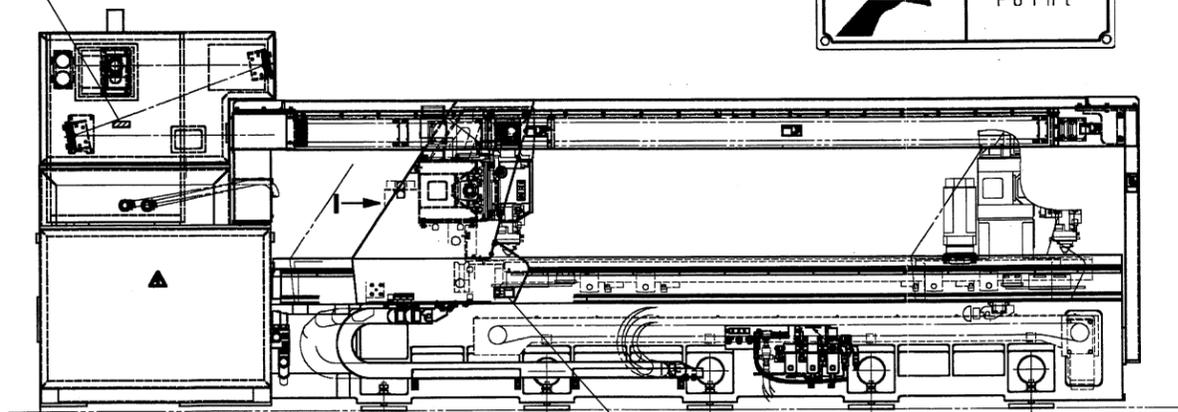
⚠ DANGER
Pinch
Point

⚠ **DANGER**

Pinch
Point

CAUTION-LASER RADIATION WHEN OPEN
AND INTERLOCKS DEFEATED.
AVOID EYE OR SKIN EXPOSURE
TO DIRECT OR SCATTERED
RADIATION.

-INVISIBLE and/or VISIBLE LASER RADIATION-
AVOID EYE OR SKIN EXPOSURE TO DIRECT OR
SCATTERED RADIATION.
-RAYONNEMENT LASER INVISIBLE ET/OU VISIBLE-
EVITER TOUT CONTACT DES YEUX OU DE LA PEAU AVEC
LES RAYONNEMENTS DIRECTS OU REFLECHIS.
IEC 825-1:1993

LASER / LASER	INVISIBLE/INVISIBLE VISIBLE/VISIBLE CLASS 4/CLASSE 4 CLASS 3A/CLASSE 3A
MAXIMUM POWER / PUISSANCE MAXI	3200W <5mW
PULSE DURATION / DUREE IMPULSION	100µS-CW CW
EMITTED WAVELENGTH / LONGUEUR D'ONDE EMISE	10.5µm 0.6-0.7µm
LASER MEDIUM / COMPOSITION GAS LASER Co/N₂/He-5/15/40%	HeNe/HeLiER o. HeNe

-SICHTBARE U/O UNSICHTBARE LASERSTRAHLUNG-
BESTRAHLUNG VON AUGE ODER HAUT DURCH
DIREKTE ODER STREUSTRAHLUNG VERMEIDEN.
-RADIAZIONE LASER INVISIBILE E/O VISIBILE-
EVITARE L'ESPOSIZIONE DEGLI OCCHI O DELLA PELLE
ALLA RADIAZIONE DIRETTA O DIFFUSA.
IEC 825-1:1993

LASER / PRODOTTO LASER	UNSICHTBAR/INVISIBILE SICHTBAR/VISIBILE KLASSE 4/CLASSE 4 KLASSE 3A/CLASSE 3A
MAXIMALE LEISTUNG / EMISSIONE MASSIMA	3200W <5mW
PULSDAUER / DURATA IMPULSO	100µS-CW CW
WELLENLÄNGE / LUNGHEZZA D'ONDA EMESSA	10.5µm 0.6-0.7µm
LASERMEDIUM / MISCELA GAS DEL LASER Co/N₂/He-5/15/40%	HeNe/HeLiER o. HeNe

CAUTION-LASER RADIATION WHEN OPEN
AND INTERLOCKS DEFEATED.
AVOID EYE OR SKIN EXPOSURE
TO DIRECT OR SCATTERED
RADIATION.

ΩMADA

SAFETY FUNCTIONS

The machine has functions that are designed to safeguard the operator as well as the machine itself as described below.

For the description of the switches mentioned in this section, refer to Part I, Controls.

Operator safety

- Automatic power shutdown:

  The CNC and the laser oscillator will be shut down automatically if an overcurrent is supplied.

- Operation interlocks:

  The machine cannot be started unless the partition doors and the laser oscillator's front cover are closed.   It also cannot be started if the optical safety device has been actuated; or if the nozzle or bend mirror unit is not installed.   The machine will stop instantly if the optical safety device is actuated during operation.

- Operation mode lock:

  Careless operation-mode changing will be prevented to avoid disruption of the machine operation — when this function is enabled by using the MODE keyswitch on the CNC control panel.

Machine safety

- Laser head protection:

  The laser head will collapse at its joint if it hits the worksheet, etc., and the machine will stop.

- Workclamp (optional) protection:

  The machine will stop if a workclamp is likely to collide with the laser head.

- Servosystem protection:

  The machine will stop if a servomotor is overloaded or an irregularity has been caused in the servosystem.

- Overtravel detection:

  The machine will stop if the laser head has overtraveled.

- Low air pressure detection:

  The machine will stop if the operating air pressure has gone down below the required pressure.

- Low laser gas pressure detection:

  The machine will stop if the laser gas pressure has gone down below the required pressure.

- Low assist gas pressure detection:

  The machine will stop if the assist gas pressure has gone down below the required pressure.

- Reduced cooling water flow detection:

  The machine will stop if the cooling water flow has been reduced below the required flow.

- Program precheck:

  The program can be checked for syntax errors and overtravels without running the machine — prior to its execution for actual cutting. (This function is enabled or disabled by the PROGRAM CHECK button on the CNC control panel.)

SPECIFICATIONS

Operating environment

Ambient temperature	5 to 35°C
Max. relative humidity	75 % without dew condensation
Illumination	Over 500 lux.

Machine

Model		FO2412	FO3015	FO4020
Axis travel	X	2870 mm	3420 mm	4350 mm
	Y	1270 mm	1550 mm	2000 mm
	Z	200 mm	200 mm	200 mm
Cutting area	X	2520 mm	3070 mm	4000 mm
	Y	1270 mm	1550 mm	2000 mm
	Z	200 mm	200 mm	200 mm
Cutting feed rate	X	0 to 20 m/min	0 to 20 m/min	0 to 20 m/min
	Y	0 to 20 m/min	0 to 20 m/min	0 to 20 m/min
Max. rapid feed	X	80 m/min	80 m/min	80 m/min
	Y	80 m/min	80 m/min	80 m/min
	Z	60 m/min	60 m/min	60 m/min
Max. worksheet weight		580 kg	850 kg	1500 kg
Table height		840 mm	840 mm	840 mm
Weight with oscillator		10 t	12 t	15 t
Power supply		AC, 3-phase, 200/220 V ±10% 50/60 Hz, 10 kVA	AC, 3-phase, 200/220 V ±10% 50/60 Hz, 10 kVA	AC, 3-phase, 200/220 V ±10% 50/60 Hz, 10 kVA

CNC control unit

Model	FANUC FS-160iLA
Controlled axes	X, Y, Z (3 axes simultaneously controlled)
Input method	3.5" floppy disk or manual data input
Minimum dimensional unit	0.001 mm
Memory capacity	Equivalent to 320 m, or 1280 or 5120 m (optional)
I/O interface	RS232C

Laser oscillator

Model	FANUC C-1500B	FANUC C-2000C AF-2000C	FANUC C-3000D AF-3000D	FANUC C-4000A AF-4000A
Rated output	1500 W	2000 W	3000 W	4000 W
Stability	±1.0 %	±1.0 %	±2.0 %	±2.0 %
Max. output	1800 W	2000 W (CW), 3300 W (Pulse peak)	3000 W (CW), 4000 W (Pulse peak)	4000 W (CW), 5000 W (Pulse peak)
Frequency range	5 to 2000 Hz	5 to 2000 Hz	5 to 2000 Hz	5 to 2000 Hz
Duty range	0 to 100 %	0 to 100 %	0 to 100 %	0 to 100 %
Laser beam	CO_2 laser beam	CO_2 laser beam	CO_2 laser beam	CO_2 laser beam
Laser beam wavelength	10.6 μm	10.6 μm	10.6 μm	10.6 μm
Laser beam mode	Low-order mode	Low-order mode	Low-order mode	Low-order mode
Laser beam diameter	Approx. 24 mm at source	Approx. 27 mm at source	Approx. 27 mm at source	Approx. 27 mm at source
Laser beam dispersion angle	Below 2 mrad	Below 2 mrad	Below 2 mrad	Below 2 mrad
Laser gas mixture ratio	5±0.25 % CO_2 40±2.00 % He 55±2.75 % N_2	5±0.25 % CO_2 40±2.00 % He 55±2.75 % N_2	5±0.25 % CO_2 40±2.00 % He 55±2.75 % N_2	5±0.25 % CO_2 40±2.00 % He 55±2.75 % N_2
Laser gas supply	0.17 MPa (1.7 kgf/cm²), 10 liters/h	0.17 MPa (1.7 kgf/cm²), 10 liters/h	0.17 MPa (1.7 kgf/cm²), 10 liters/h	0.17 MPa (1.7 kgf/cm²), 10 liters/h
Cooling water supply	0.35±0.1 MPa (3.5±1 kgf/cm²), over 50 liters/min	0.35±0.1 MPa (3.5±1 kgf/cm²), over 75 liters/min	0.35±0.1 MPa (3.5±1 kgf/cm²), over 120 liters/min	0.35±0.1 MPa (3.5±1 kgf/cm²), over 160 liters/min
No. of bend mirrors	3	3	3	3
Power supply	200 V (±10 %), AC, 50/60 Hz (±1 Hz), 23 kVA, 3-phase	200 V (±10 %), AC, 50/60 Hz (±1 Hz), 33 kVA, 3-phase	200 V (±10 %), AC, 50/60 Hz (±1 Hz), 44 kVA, 3-phase	200 V (±10 %), AC, 50/60 Hz (±1 Hz), 55 kVA, 3-phase
Dimensions (W x D x H)	2050 x 750 x 1056 mm	2050 x 750 x 1056 mm	2050 x 750 x 1056 mm	2050 x 750 x 1176 mm

Information on sound

INFORMATION ON SOUND IN ACCORDANCE WITH ACT 92767 Section 1.7.4
Appendix 1

Transposing into French law the 89/392 Machine Directive and mentioned in article R233-84 from the Labor Code.

AUDIBLE EMISSION

AT WORK STATION:

LA eq = 64.2 dBA no load LA eq = 76.0 dBA* normal use with aluminum sheet LP peak < 130 dBL

Measurements made: according to standard **ISO 8500**

*Work carried out at 1.60 m from the floor and dust collector off

2-A5052 aluminum sheet

Thickness: 6 mm

Size: 1000 x 1000 mm

Cutting feed rate: 0.8 m/min

Laser output: 2000 W

Assist gas pressure: 0.8 MPa
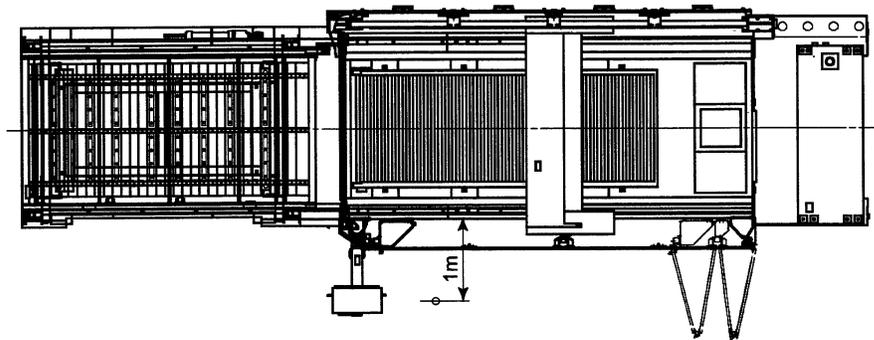
ADVICE FOR DECREASING THE DAILY SOUND EXPOSURE LEVEL

The sound level emitted by a machine depends greatly upon the setting up conditions and the environment of that machine, on the thickness and nature of the materials being worked and of the tooling being used.

Depending on the site layout, it may be necessary to use technical means to reduce noise or to organize work so as to protect neighboring workstations: workstation distances, screens, partitions, acoustic correction of premises' walls, decreased exposure time of operators to noise.

Wearing individual aural protection is highly recommended in all cases.

LIST OF THE REGULATIONS AND STANDARDS TAKEN IN REFERENCE IN THE CONCEPTION AND CONSTRUCTION OF THE LASER MACHINE

Subject	French standard	European standard standardized to the project
Electromagnetic compatibility directive	Act 92/31	89/336 CEE
Machine directive/Regulations and procedures	Act 92 765/67	89/392 CE
Graphic symbols used in the doc/diagrams		CEI 03201 to 03211
Graphic symbols of signals		CEI 417
Classification of the protection index on envelops		EN 60529/92
Conventional rotation of the movements		CEI 447/74
Separation transformer		EN 60742/89
Electric equipment of machines		EN 60204.1/93
Graphic, hydraulic and pneumatic symbols	E 04056	
Emergency stop		EN 418/92
Body approach speed		pr EN 999
Protection of upper organs moving away		EN 294/92
Minimum distances		EN 349
Electrical control footswitches	E 09031/32	
Two-hand control		pr EN 574
Locking and interlocking device		pr EN 1088/93
Machines stopping times	E 9052	
Safety in T.M. conception		EN 292.1/2
Control organs rotation of the T.M.	E 60031	
Interlock: start-up prevention		pr EN 1037
Specifications symbolization on T.M.	E 60032	
Measurement of the acoustic pressure at working station		
List of graphic symbols for industrial	X 05005	ISO 7000
Colors and safety signals	X 08003	
Ergonomic principles		ENV 26385
Signalization applicable to working station	X 35101	ISO 3864
Behaviors and dimensions for the human being at work	X 35104	
Operation organs	X 35105	
Effort limits	X 35106	
Access dimensions to machines		pr EN 547-2
Risk analysis		pr EN 1050/94
Electromagnetic compatibility		EN 50081.2
Measurements of radio-electric interferences		EN 55011/91 EN 50.082-2-95 EN 61-4-2/4/8

Each machine comes with a certificate of conformity with respects to the CE visa as described below.

CERTIFICATE OF CONFORMITY CE
RELATIVE TO WORKING EQUIPMENTS

****

The undersigned manufacturer

AMADA Co., LTD.
200, ISHIDA, ISEHARA - SHI,
KANAGAWA Pref. 259-1196 JAPAN
(JAPAN)

certifies that the new below designated equipment : Laser Cutting Machine

TYPE : FO CE
MODEL :   Serial No. ;

complies with the requlations applicable to it :

· European Reference : 89/392/EEC Directive ; Directive CEM 89/336/CEE modified by Directive 93/68/CEE.
· European standards : EN 292-1, EN 292-2, EN 294, EN 349, EN 418, EN 457, EN 60204

For the design and creation of the machine, French standard bases have been used.

At   **Fujinomiya-shi (JAPAN)**   Name :
Date   Function : General Manager
                                              Quality Assurance Dept.
                                   Signature :

Each machine is fitted with a numerical plate fixed permanently on the frame together with a CE plate in accordance with the current regulation.
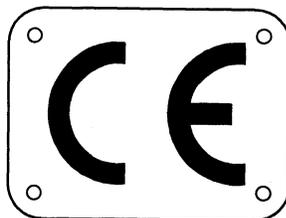
LASER CONTOUR MACHINE MACHINE DE DECOUPE LASER		
LASERSCHNEIDMASCHINE MACCHINA LASER		
MODEL / MODELE MODELL / MODELLO		
SERIAL No. / N° DE SERIE SERIEN NR. / N° SERIE		-
CAPACITY / PUISSANCE LASER LASER LEISTUNG / CAPACITA		kW
POWER REQUIRED / PUISSANCE INSTALLEE ANSCHLUSSWERT / ALIMENTAZIONE		kVA
WEIGHT / POIDS GEWICHT / PESO		t f
DATE MANUFACTURED/ DATE DE FABRICATION BAUJAHR / DATA DI PRODUZIONE		

AMADA   MADE IN
                         JAPAN

xxi

LIGHT PATHS IN THE X-, Y-, AND Z-AXES

The following figures show the paths inside the X-, Y-, and Z-axes through which a laser beam passes. Do not block these paths with your hand, finger, or any other thing.

A (X-AXIS LENGTH)

BELLOWS COVER

BELLOWS COVER
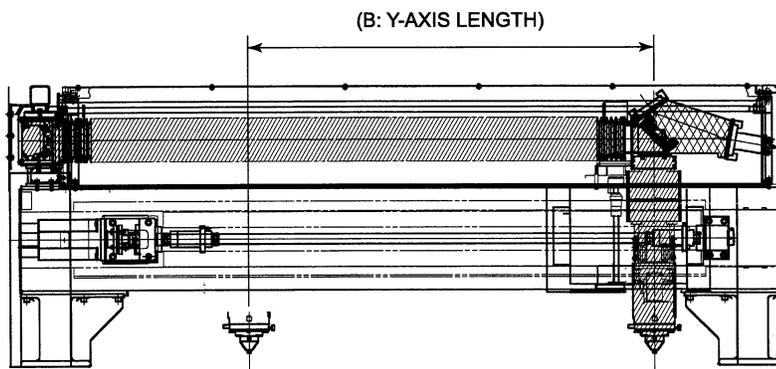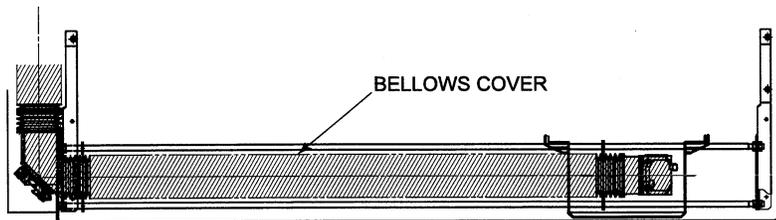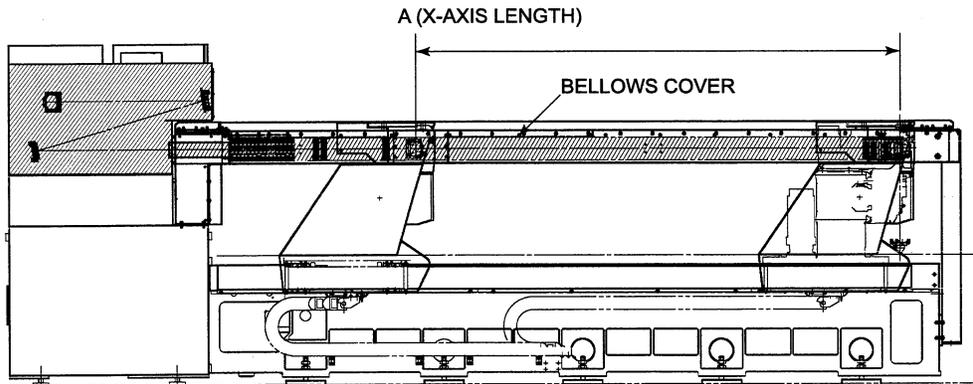
(B: Y-AXIS LENGTH)

Machine model	A: X-axis length	B: Y-axis length
FO2412	2870 mm	1270 mm
FO3015	3420 mm	1550 mm
FO4020	4350 mm	2000 mm

Part I

Controls

GENERAL VIEW

SHUTTLE TABLE

CNC CONTROL PANEL

CARRIAGE

PARTITION

OSCILLATOR

SHUTTLE TABLE

PARTITION

OSCILLATOR

AMADA

CNC CONTROL PANEL

UPPER PANEL

[1] Softkeys

There are ten unlabeled keys below the screen.   Their currently assigned functions, which vary from one working session to another, are identified by the labels shown on the screen immediately above the softkeys.

The arrowhead keys at either end of the row of softkeys are used to change between the currently shown labels and additional labels — if there are more functions than they can be shown at a time.

When no functions are assigned to softkeys, blank labels are shown.

[2] Reset (⟦⟧) key

This key is used to reset the CNC.

[3] Help (⟦⟧) key

This key is used to show the help display.

When the machine has optional subcarriage, press the Help key together with the Shift key to change to a series of displays for either the main carriage or subcarriage.

[4] Shift (⟦⇧⟧) key

Press this key in combination with an address key to key-in the character shown on the lower right keytop of the address key.

[5] Address keys

These keys are used to key-in address characters.   Press the Shift key and then an address key for the character shown on the lower right keytop.

[6] Numeric keys

The numeric and decimal point keys are used to key-in numeric data.

[7] Slash (/) key

This key is used to key-in a slash character.

[8] EOB key

This key is used to key-in an end-of-block code (;).

[9] Cancel (⟦⟧) key

This key is used to erase a keyed-in character in the display's buffer area.

[10] Alter (⬦) key

This key is used to change a word with a new word in the program in memory.

[11] Insert (⬦) key

This key is used to enter a program block into memory when creating a new program.   Also used to insert a word or words in the program in memory.

[12] Delete (⬦) key

This key is used to delete a word or words in the program in memory. Also used to delete an entire program.

[13] Input (⬦) key

This key is used to enter the keyed-in data into memory.

[14] Page (⬦⬦) keys

These keys are used to change the page displayed on the screen.

[15] Cursor (⇧ ⇩ ⇦ ⇨) keys

These keys are used to move the cursor.

[16] Display selection keys

These keys are used to select displays.

- **Position (⊞) key**

  Shows the Position display.

- **Program (⬦) key**

  Shows the Program display.

- **Offset/Setting (⬦) key**

  Shows the Offset/Setting display.

- **Custom (⬦) key**

  Shows the Executor display.

- **System (⬦) key**

  Shows the System display.

- **Message (?) key**

  Shows the Message display.

- **Graphic (⬦) key**

  This key is not used.

LOWER RIGHT PANEL

[17] START button

Starts operation when pressed in the MEMORY or MDI mode.   The button light comes on during the operation.

[18] STOP button

Stops the ongoing single operation.   The button light comes on when the button is pressed and for the duration of the stopped condition. The stop will be cleared if the button is pressed again.   At the same time, if the stop occurs due to an alarm on the machine, the button light will come on.

[19] EMERGENCY STOP button (with an unlocking key)

Stops and discontinues the operation of the machine in any mode.   The stopped operation cannot be resumed and must be started again from the beginning.   The button will be locked when pressed and can be unlocked by inserting the key and turning it clockwise.   Remove the key after unlocking the button.

⚠ WARNING	● First remove the cause of the stop, then check the safety around the machine and unlock the button. After clearing the emergency stop, be sure to zero-return all the machine axes.

[20] SHUTTER keyswitch

Selects the use of the CO_2 laser beam for cutting and enables the laser shutter to open when turned to ON.   Turn the keyswitch to OFF to select the He-Ne laser beam for position confirmation or maintenance operation.

[21] MODE buttons

These buttons are used to select a CNC mode.   They are enabled only when the MODE keyswitch is turned to ON.   The button light comes on when the mode is selected.   When the HANDLE button (in the lower middle panel) is pressed, operation from the handwheel control box will be enabled and all MODE button lights will be turned off.   Operation from the CNC control panel will be resumed if the HANDLE button is pressed again or any of the MODE buttons is pressed.

NOTE

● The RETRACT mode is selected for the first time when the power is turned on.

● RETRACT button

Selects the RETRACT mode to permit zero-return of a machine axis or axes.

• **MEMORY button**

Selects the MEMORY mode to permit execution of a program or scheduled series of programs in the CNC memory.   The program and sequence numbers stored in the CNC memory can be searched for.

• **MDI button**

Selects the MDI mode to permit MDI operation.   Parameter and setting data can be entered.

• **MANUAL button**

Selects the MANUAL mode to permit manual feed of a machine axis.

• **EDIT button**

Selects the EDIT mode to permit program editing and registration, direct programming, etc.

[22] ASSIST GAS pressure indicator (option)

Indicates the pressure of the assist gas being discharged from the laser head.   Available only when the optional assist gas CNC control is provided.

[23] ALARM RESET button

Clears an alarm when pressed.   Remove the cause of the alarm beforehand when the machine is in the alarm condition and the ALARM light on the CNC control panel comes on.

This button can be used only for clearing the alarm.   However, if the Reset key on the CNC control panel is used to clear an alarm, the operation concerned must be started again from the beginning.

[24] FEED buttons

These buttons have different functions in the RETRACT mode and the MANUAL mode.

• **+X, +Y, +Z, buttons**

These three buttons are used to return the X-, Y- and Z-axes to their origins in the RETRACT mode.   The button light comes on when the corresponding axis is returned to its origin.

• **+X, –X, +Y, –Y, +Z, –Z buttons**

These six buttons are used to feed the X-, Y- and Z-axes in the indicated direction in the MANUAL mode.

[25] OT RELEASE (⊕) button

Used to release an overtravel of the X- or Y-axis in combination with the corresponding FEED button — the two buttons must be pressed together.

This button is also used to retract the overtraveled focal point axis (optional) in combination with the +B or –B button on the lower middle panel.

[26] SAFETY DEVICE RESET button

Resets the condition that has turned off the SAFETY DEVICE READY light (see below), which will come on again when this button is pressed after removing the cause.

[27] SAFETY DEVICE READY light

Comes on when the sliding doors and the laser oscillator's front cover have been closed, and the SAFETY DEVICE RESET button (see above) is pressed.   The light goes out when the optical safety device is actuated, or one of the partition doors or the laser oscillator's front cover is opened — the light will come on again when the SAFETY DEVICE RESET button is pressed after removing the cause.

[28] PARTITION DOOR OPEN button

Opens the partition doors when pressed. This button is used when the maintenance operation is performed.

[29] PARTITION DOOR CLOSE button

Closes the partition doors when pressed. This button is used when the maintenance operation is performed.

LOWER MIDDLE PANEL

[30] EDIT PROTECT keyswitch

Protects the program in the CNC memory from being overwritten or erased when turned to ON.   Keep the switch in the ON position unless the program must be edited.   The switch will be locked in the ON position when the key is removed.

NOTE

● The processing condition files cannot be protected.

[31] HANDLE button

Enables operation of the handwheel control box.   The button light comes on when pressed.

[32] AUTO POWER OFF button

Enables the auto-power-off function.   The power for the machine will be automatically turned off upon completion of operation when this button is pressed and lighted.

[33] LAMP button

Turns on the work light when pressed and lighted.   Turns off the work light when pressed again.

[34] RATE buttons

Reduces the manual feed rate and rapid feed rate when one of the FEED buttons is pressed and when G00 is commanded in the program. When one of the RATE buttons is pressed, its light comes on.   The manual feed rate and rapid feed rate cannot be reduced unless one of the RATE buttons is pressed (lighted).   The light of the pressed RATE button goes out when the RATE button is pressed again.

- **25% button**

  Reduces the manual feed rate and rapid feed rate to 25%.

- **50% button**

  Reduces the manual feed rate and rapid feed rate to 50%.

- **75% button**

  Reduces the manual feed rate and rapid feed rate to 75%.

[35] MULTIPLE PART MODE buttons

These buttons are used to select the method of cutting for a multi-part program.   One of the buttons is always lighted, but this has no effect unless the program is a multi-part one.

- #### • FIRST PROCESS (⊞) button

  Permits to cut only the first part which is used as basis to cut the remaining parts.

- #### • OTHERS PROCESS (⊞) button

  Permits to cut the remaining parts after the first part has been cut by using the FIRST PROCESS button.

- #### • ALL PROCESS (⊞) button

  Permits to cut all the parts.

[36] MODE keyswitch

Enables the MODE buttons when turned to ON.   Keep this switch turned to OFF when the changing of modes is not required.

[37] TRACE OFF button

Disables the Z-axis tracking sensor when pressed and lighted.   To enable the sensor, press the button again, turning off its light.

[38] SINGLE BLOCK button

Permits the single-block operation when pressed and lighted.

Each time the START button is pressed in the single-block operation, the machine stops after executing a single block in the program.

The machine does not stop after a single block, however, when M760 is commanded to open and close the shutter, or when a user macro program is being executed.

[39] BLOCK SKIP button

Permits the block-skip operation when pressed and lighted.

In the block-skip operation, the CNC unit executes the program by ignoring any block beginning with a slash "/" (from "/" to ";").

[40] OPT STOP button

Enables the optional stop function when pressed and lighted.   When the optional stop function is enabled, the automatic operation of the machine is stopped by M01 in the program.

Disables the optional stop function when pressed again.   When the optional stop function is disabled, the automatic operation of the machine cannot be stopped by M01 in the program.

[41] PROGRAM CHECK button

Permits the program check.   The machine can be run dry when its automatic operation is started in the program check.   During the dry run, the coordinate values shown on the display change, but the axes do not move, and the M codes are not executed.

After the dry run, the machine must be manually zero-returned.

[42] REMOTE button

Permits the DNC operation according to a program read from an external input/output device when pressed and lighted.

Used together with the SERIAL button for the DNC operation of the machine.

Turns off the light and changes the operation mode to the normal operation according to a program stored in the memory of the CNC unit when pressed again.

[43] SERIAL button

Changes the usable input/output device from the floppy disk drive to the RS232C interface at the bottom of the CNC control cabinet when pressed and lighted.

Changes the usable input/output device back to the floppy disk drive when pressed again.

```
        NOTICE
```

● When exchanging data through the RS232C interface, relevant parameters must be set to suit the input/output device to be used.
  Ask the AMADA engineer to set the parameters.
  The I/O channel 1 is the RS232C interface.
  The I/O channel 0 is the floppy disk drive.   Do not change this setting. Otherwise the floppy disk drive may not properly operate.

[44] MANUAL CUT keyswitch

Enables manual cutting when turned to ON and disables manual cutting when turned to OFF.

[45] MANUAL CUT ENABLE button

This button is used to perform manual cutting.   Set cutting conditions, turn the MANUAL CUT keyswitch to ON, press and hold one of the FEED buttons to determine the cutting direction, and press the MANUAL CUT ENABLE button together with the SWITCH ENABLE button.   Manual cutting is performed as long as the three buttons are pressed and held.

[46] SWITCH ENABLE button

Enables the operation of the following buttons when pressed and held:

- +A and –A buttons
- +B and –B buttons
- CONVEYOR FWD button
- CONVEYOR REV button
- MANUAL CUT ENABLE button

The above buttons are underlined to distinguish them from the other buttons.

[47] MIST button (option)

Pressed to adjust the cooling water flow rate when the machine is equipped with the optional HS cooling cut head (WACS nozzle).

[48] FEED buttons (option)

- **+B button**

  Moves the B-axis (focal point axis) in the plus direction when pressed and held together with the SWITCH ENABLE button in the MANUAL mode.   This button is used to retract the overtraveled B-axis when the optional focal point CNC control is provided.

- **–B button**

  Moves the B-axis (focal point axis) in the minus direction when pressed and held together with the SWITCH ENABLE button in the MANUAL mode.   This button is used to retract the overtraveled B-axis when the optional focal point CNC control is provided.

- **+A button**

  Moves the A-axis of the optional pipe index or C-type index device in the plus direction (or clockwise when viewed from the operation position) when pressed and held together with the SWITCH ENABLE button in the MANUAL mode.

- **–A button**

  Moves the A-axis of the optional pipe index or C-type index device in the minus direction (or counterclockwise when viewed from the operation position) when pressed and held together with the SWITCH ENABLE button in the MANUAL mode.

[49] CONVEYOR AUTO button (option)

Enables the automatic operation of the optional chip conveyor when pressed and lighted.   The conveyor operates forward when the program is executed in the MEMORY or MDI mode.   The conveyor will stop upon completion of the program.   To disable the conveyor, press this button again, turning off its light.

[50] CONVEYOR FWD button (option)

Operates the optional chip conveyor forward when pressed and held together with the SWITCH ENABLE button in the MANUAL mode — provided that the light of the CONVEYOR AUTO button is out.

[51] CONVEYOR REV button (option)

Operates the optional chip conveyor backward when pressed and held together with the SWITCH ENABLE button in the MANUAL mode — provided that the light of the CONVEYOR AUTO button is out.

LOWER LEFT PANEL

[52] Power ON button

Turns on the power to the CNC control unit.

[53] Power OFF button

Turns off the power to the CNC control unit.

NOTE

● Do not turn off the power to the CNC control unit during program execution or while the floppy disk drive is reading a floppy disk.

[54] NC READY light

Comes on when the CNC is ready for operation.

[55] ALARM light

Comes on if the CNC or the machine has an alarm condition.

[56] WARNING light

Blinks when a cautioning prompt is generated urging you to proceed with the pending step.

[57] PROGRAM STOP light

Comes on when the machine is stopped due to a program stop (M00) or optional stop (M01) command.

[58] LASER READY light

Blinks when the laser oscillator is making preparation to the start or shutting off.   Comes on when preparation for starting the laser oscillator has been completed and a high-voltage can be supplied to the laser oscillator.

[59] HIGH VOLTAGE light

Blinks when preparation for supplying a high-voltage to the laser oscillator is making.   Comes on when a high-voltage is supplied to the laser oscillator.

NOTE

● If the supply of a high-voltage is stopped during operation of the laser oscillator because of an event such as an emergency stop, first turn the LASER keyswitch on the CNC control panel to OFF and then turn it back to ON in five seconds.   The HIGH VOLTAGE light will blink and the preparation for high-voltage supply will be resumed.

[60] SHUTTER OPEN light

Comes on when the laser shutter is open.

[61] LASER keyswitch

Starts or stops the laser oscillator activation.

OFF position: Disables the laser oscillator.   If the keyswitch is turned to OFF during the oscillator operation, the oscillator will stop automatically.   (Supply of a high-voltage to the oscillator is stopped and laser gas is discharged.)

ON position: Starts the laser oscillator.   (Laser gas is supplied to the oscillator and then a high-voltage is supplied when the oscillator is filled with the laser gas.)

If an emergency stop occurs during starting of the oscillator, the HIGH VOLTAGE light will go out and the LASER READY light will start blinking.   After a moment, the LASER READY light will go out.
In this case, turn the SHUTTER keyswitch to OFF, clear the emergency stop condition, reset the alarm, and then turn the LASER keyswitch to OFF and turn it back to ON within five seconds.
The LASER READY and HIGH VOLTAGE lights will then blink.   After finishing preparation for supplying a high-voltage, the HIGH VOLTAGE light will come on and cutting will again be available.

HANDWHEEL CONTROL BOX

The switches on the handwheel control box can be used for operation only when the HANDLE button on the CNC control panel is lighted.

[1] Magnification selection switch

Selects the feed magnification for the handwheel.

- **×1:** Feeds in 0.001 mm per graduation.
- **×10:** Feeds in 0.01 mm per graduation.
- **×100:** Feeds in 0.1 mm per graduation.
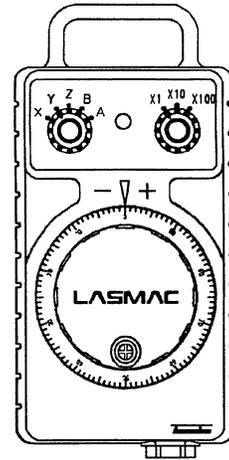
[2] Axis selection switch

Selects the axis (X, Y, Z, B or A) to be moved by the handwheel.

[3] Handwheel

Moves the axis that was selected with the axis selection switch at the feed rate that was selected with the magnification selection switch. Turning clockwise moves the axis in the plus direction while turning counterclockwise moves it in the minus direction.

ASSIST GAS CONTROL PANEL

This panel is used to regulate the assist gas pressure. The assist gas control switches are not installed on the panel when the optional assist gas CNC control is provided.
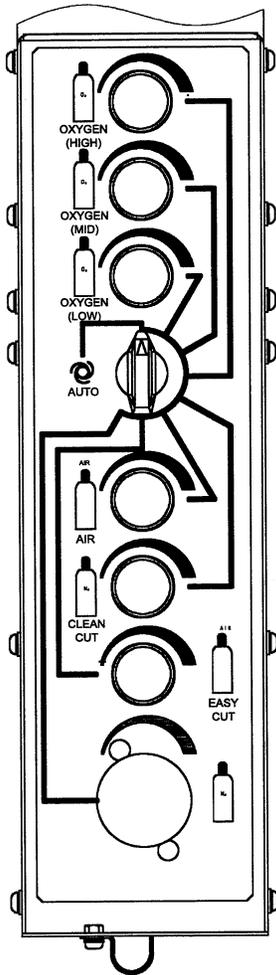
[1] Assist gas selection switch

Selects the assist gas to regulate its pressure. When the switch is turned to a position other than AUTO, the specified gas jets out of the laser head.

AUTO:	Normally this position is specified. Gas is automatically selected according to the CNC command. Gas jets out when a command is issued from the CNC.
OXYGEN (LOW):	Low-pressure oxygen is specified.
OXYGEN (MID):	Medium-pressure oxygen is specified.
OXYGEN (HIGH):	High-pressure oxygen is specified.
CLEAN CUT:	Nitrogen is specified.
AIR:	Air is specified.
EASY CUT:	Easy Cut air is specified.

[2] Gas pressure regulator knobs

Regulate the pressure of the assist gas that has been selected with the assist gas selection switch. Pull the knob concerned and turn it until the setting pressure is reached. Then push to lock it.

HIGH-PRESSURE NITROGEN GAS CONTROL PANEL (OPTION)

Used to regulate the gas pressure when the optional high-pressure nitrogen gas control is provided.

Installed separately from the assist gas control panel.

Even when the optional assist gas CNC control is provided, this panel is installed to manually regulate the pressure of the high-pressure nitrogen gas.
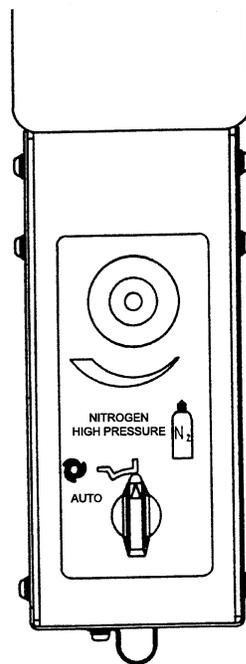
[1] High-pressure nitrogen gas selection switch

Turned to either of the following positions to regulate the pressure of the high-pressure nitrogen gas:

AUTO: Normally this position is specified. Gas jets out when a command is issued from CNC.

NITROGEN HIGH PRESSURE: High-pressure nitrogen gas jets out.

[2] High-pressure nitrogen gas pressure regulator knob

Used to regulate the pressure of the high-pressure nitrogen gas when the high-pressure nitrogen gas selection switch is turned to NITROGEN HIGH PRESSURE.

OTHERS

Other controls for the machine are as follows:

[1] Machine circuit breaker switch

Turns on and off the power to the machine and CNC. The switch is set automatically to the TRIP position in the event of an overcurrent. Return the switch to the ON position after removing the probable cause.

The switch lever can be locked with the padlock when the switch is turned off.
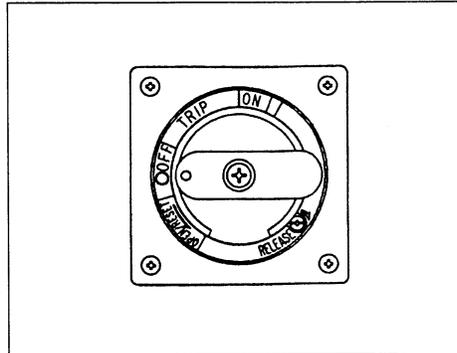
[2] Laser oscillator circuit breaker switch

Turns on and off the power to the laser oscillator. The switch is set automatically to the TRIP position in the event of an overcurrent. Return the switch to the ON position after removing the probable cause. The light on the left side of the switch comes on when the power is turned on.

The switch lever can be locked with the padlock when the switch is turned off.
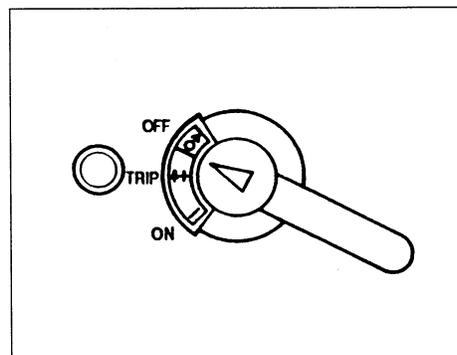
[3] EMERGENCY STOP button (with an unlocking key)

Besides the EMERGENCY STOP button on the CNC control panel, another EMERGENCY STOP button is installed. Stops and discontinues the operation of the machine in any mode. The stopped operation cannot be resumed and must be started again from the beginning. The button will be locked when pressed and can be unlocked by inserting the key and turning it clockwise. Remove the key after unlocking the button.

⚠ WARNING	● First remove the cause of the stop, then check the safety around the machine and unlock the button. After clearing the emergency stop, be sure to zero-return all the machine axes.

I-20

[4] I/O interface

The RS232C interface is used for connecting an input/output device. This interface is located at the bottom of the CNC control unit.
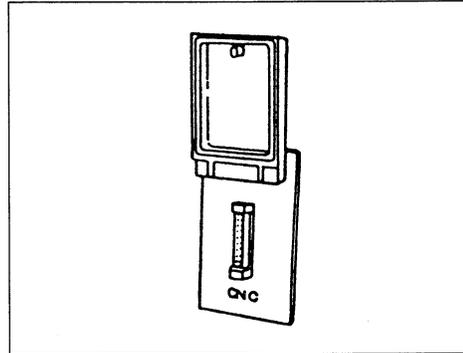
[5] Workclamp operating foot switch (option)

Press the foot switch to open or close the optional workclamps. During automatic operation, the foot switch can be used only when the machine is stopped by the program stop command (M00) or optional stop command (M01).
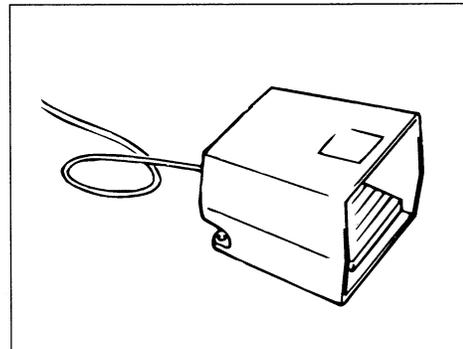
NOTE

● To close the workclamps securely, the foot switch must be held pressed for 10 sec or more. When closing the workclamps, keep your hands away from them.

[6] LASER ALIGNMENT keyswitch

Installed in the electrical control unit and used by the AMADA engineer when adjustment is required. (The electrical control unit cannot be closed unless the key is removed from the switch.)

LASER ALIGNMENT
OFF   ON
O   I
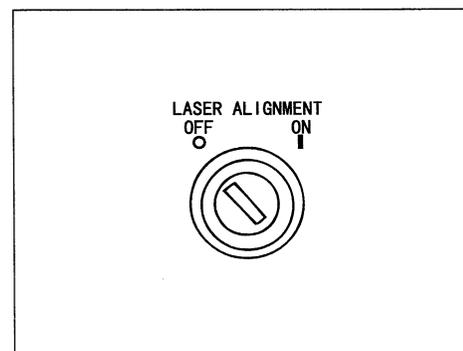
⚠ WARNING   ● Keep the switch turned to OFF and remove the key.

[7] MACHINE INSPECTION keyswitch

Installed in the CNC control
unit and used by the
AMADA engineer when the
maintenance operation is
performed.

MACHINE INSPECTION
OFF   ON
 O   I

[8] SHUTTER OPEN LS switch

Installed in the CNC control
unit and used by the
AMADA engineer when the
maintenance operation is
performed.

SHUTTER
OPEN LS

CANCEL

ENABLE

Part II

Displays

DESCRIPTION

The displays to be shown on the screen are divided into two types: CNC display and executor display. Programs, CNC parameters, and alarms are handled on the CNC displays.

Processing condition files and machine parameters are handled on the executor displays. For the operations to be performed on the CNC and executor displays, refer to the applicable sections.

Press one of the Position, System, Program, Offset/Setting and Message keys to change from an executor display to a CNC display. Press the Custom key to change from a CNC display to an executor display. The last executor display shown before the change to the CNC display will be shown again on the screen.

There are two series of displays when the machine has the optional subcarriage: one is for the main carriage and the other for the subcarriage. Press the Help key together with the Shift key to change to either series of displays. "SUB" is shown to indicate that a subcarriage display is active. A subcarriage display can be used in the same way as a corresponding main carriage display. The subcarriage has no executor displays.

<u>NOTICE</u>

● Never press the Reset key. Doing so will terminate the on-going automatic operation.

CNC DISPLAYS

Programs, CNC parameters, and alarms are handled on the CNC displays.   Each CNC display consists of fixed and variable areas.

Press one of the Position, System, Program, Offset/Setting and Message keys to change from an executor display to a CNC display.

Press the Custom key to change from a CNC display to an executor display.

The five left-hand softkeys in the fixed area remain unchanged in key assignments, and the five right-hand softkeys in the variable area change in key assignments with the display selected on the screen.

Fixed area

```
[1]                    [2]              [3]   [8]    [4]
                                                                      [6]
ACTUAL POSITION          TESTCUT      O 0 0 5 0   /   N 0 0 0 0 1
[5]          (ABSOLUTE)                  F                    0 MM/M    [7]
      X          0 . 0 0 0                         PART COUNT    1234
      Y          0 . 0 0 0         RUN TIME   12H34M  CYCLE TIME  0H03M16S
      Z          0 . 0 0 0        ┌─────────────────────────────────┐
[10]                              │ PROGRAM                         │   [9]
                                  │ O50 (TESTCUT) ;                 │
                                  │ M102 (SPC1.0) ;                 │
                                  │ G92 G90 X50 Y50 ;               │
      (MODAL)                     │ G93 X0 Y0 ;                     │
   G00  G35      F     M          │ M100 ;                          │
   G17  G97            M          │ E002 ;                          │
   G90  G57            M          │ G00 G41 X25 Y25 ;               │   [11]
   G21  G64      H     D     T    │ M103 ;                          │
   G40  G78                       │ G01 X25 Y0 ;                    │
   G49                            │ G00 ;                           │
                S                 │                                 │
             SACT  0              │ >_                              │   [12]
                                  │ JOG **** *** ***    15 : 32 : 27│
                                  └─────────────────────────────────┘
   │ ABS │ REL │ ALL │   │   │ PRGRM │ MDI │   │ NEXT │(OPRT)│ + │
```
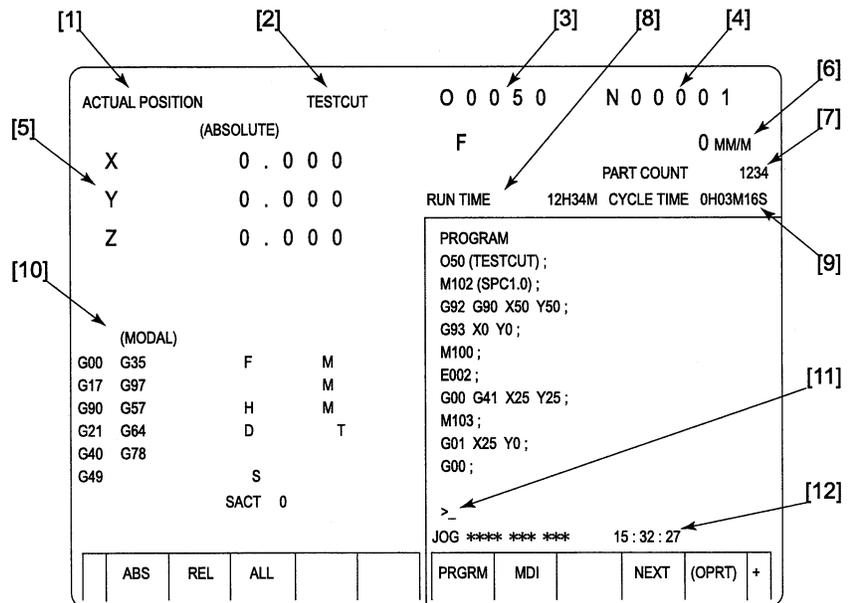
The fixed area shows the following information:

[1] Fixed area display name

Shows the name of the currently selected display.

[2] Program name

Shows the name of the currently called program.

[3] Program No.

Shows the number of the currently called program.

[4] Sequence No.

Shows the number of the currently called sequence.

[5] Actual position

Shows the current position of each machine axis. Press an appropriate softkey to select one of the following displays:

(1) ABSOLUTE
Press the ABS softkey to show the current position of each machine axis in the program coordinate system (absolute coordinate system) set by G92.

(2) RELATIVE
Press the REL softkey to show the current position of each machine axis in the coordinate system (relative coordinate system) with the operator-preset position as the origin. For the method of presetting the origin, refer to "Actual position displays."

(3) ALL
Press the ALL softkey to show the current position of each machine axis in all of the absolute, relative, and machine coordinate systems. The remaining travel distance (DISTANCE TO GO) for each axis in the currently executed block of the program is also shown in the MEMORY or MDI mode.

(4) HANDLE INTERRUPTION
Press the HNDL softkey to show the following items:

- INPUT UNIT: Axis travel in the CNC input unit system (mm or inch)
- OUTPUT UNIT: Axis travel in the handwheel control box output unit system (mm or inch)
- RELATIVE: Current axis position in the relative coordinate system
- DISTANCE TO GO: Remaining travel distance for each axis in the currently executed block of the program (shown only in the MEMORY and MDI modes)

[6] Speed

Shows the actual axis travel speed.

[7] PART COUNT

Shows the number of times the program has been executed (or M02, M30, or G50 has been commanded).

[8] RUN TIME

Shows the accumulated period of time in which the machine has automatically operated, excluding the idle time.

[9] CYCLE TIME

Shows the time in which the machine has operated in one cycle, excluding the idle time. The record is automatically reset to zero when the machine is started in the CNC reset state, so that the cutting time of one cycle of automatic operation can be known.

[10] MODAL

Shows the modal G code and M-, S-, H-, D-, T- and F-code data currently effective in the CNC.

[11] Key entry buffer

Shows the data stored in the key entry buffer. Any keyed-in data is first stored in the key entry buffer and is used in the CNC only when the Insert key, Input key, SRH ↓ softkey, or any other appropriate key or softkey is pressed.

[12] Status line

Shows the CNC status, time, and message.

"SUB" is shown to indicate that a subcarriage display is active.

Variable area

The variable area has six groups of displays as described below. Some displays can be shown full-screen (or on the entire screen) by pressing an appropriate softkey.

- Actual position displays: Show the current position of each machine axis.
  - ACTUAL POSITION (ABSOLUTE)
  - ACTUAL POSITION (RELATIVE)
  - ACTUAL POSITION
  - HANDLE INTERRUPTION
- System displays: Handle CNC parameters and other information necessary to operate the machine.
  - PARAMETER
  - DIAGNOSTIC
  - PMC
  - SYSTEM CONFIG
  - PIT-ERROR SETTING
  - SERVO SETTING
  - READ/PUNCH
  - COLORING
  - PERIODICAL MAINTENANCE
  - MAINTENANCE INFORM
  - AMPLIFIER SETTING

- Program displays: Register and edit programs.
  - PROGRAM
  - PROGRAM DIRECTORY
  - DIRECTORY (FLOPPY)
  - PROGRAM (MDI)
  - PROGRAM (NEXT BLOCK)
  - PROGRAM RESTART
- Offset/setting displays: Handle CNC parameters and other information necessary to operate the machine.
  - OFFSET
  - SETTING
  - WORK COORDINATES
  - VARIABLE
  - LASER POWER
  - LASER SETTING
  - TRACE SETTING
  - CUTTING
  - PIERCING
  - STATUS
- Message displays: Show alarms and other information.
  - ALARM HISTORY
  - ALARM MESSAGE
  - OPERATOR MESSAGE
- Help displays: Show help for alarms and operation methods.
  - ALARM DETAIL
  - OPERATION METHOD
  - PARAMETER TABLE

Actual position displays

Press the Position key to show an actual position display.   Press an appropriate softkey in the variable area to select one of the four actual position displays described below.   The selected display will appear full-screen.

ACTUAL POSITION (ABSOLUTE) display

Press the ABS softkey to show the current position of each machine axis in the program coordinate system set by G92.   The current position of each machine axis in the machine coordinate system is also shown.   The remaining travel distance (DISTANCE TO GO) for each axis in the currently executed block of the program is also shown in the MEMORY or MDI mode.

```
ACTUAL POSITION          TEST        O 0 0 5 0      N 0 0 0 0 1
              (ABSOLUTE)               (MACHINE)       (DISTANCE TO GO)
    X           0 . 0 0 0       X    0.000      X    0.000
                                Y    0.000      Y    0.000
    Y           0 . 0 0 0       Z    0.000      Z    0.000

    Z           0 . 0 0 0


        (MODAL)
G00  G35          F          M
G17  G97                     M
G90  G57          H          M
G21  G64          D          T
G40  G78                              F                        0 MM/M
G49
                  S                          PART COUNT      1234
              SACT  0             RUN TIME   12H34M CYCLE TIME 0H03M16S

                                  MEM **** *** ***    15 : 32 : 27

 |   |   |   |   |   | [ABS] | REL | ALL | HNDL | (OPRT) |
```

ACTUAL POSITION (RELATIVE) display

Press the REL softkey to show the current position of each machine axis with the operator-preset position as the origin.   The current position of each machine axis in the machine coordinate system is also shown. The remaining travel distance (DISTANCE TO GO) for each axis in the currently executed block of the program is also shown in the MEMORY or MDI mode.   For the method of presetting the origin of the relative coordinate system, refer to "Setting up actual position displays."

```
ACTUAL POSITION          TEST        O 0 0 5 0      N 0 0 0 0 1
                (RELATIVE)             (MACHINE)       (DISTANCE TO GO)
     X          0 . 0 0 0      X   0.000       X   0.000
                               Y   0.000       Y   0.000
     Y          0 . 0 0 0      Z   0.000       Z   0.000

     Z          0 . 0 0 0


        (MODAL)
G00  G35         F       M
G17  G97                 M
G90  G57         H       M
G21  G64         D       T
G40  G78                        F                        0 MM/M
G49             S                            PART COUNT       1234
            SACT  0        RUN TIME     12H34M  CYCLE TIME  0H03M16S

                           MEM **** *** ***        15 : 32 : 27
   |    |    |    |    |    | ABS | [REL] | ALL | HNDL | (OPRT) |
```

ACTUAL POSITION display

Press the ALL softkey to show the current position of each machine axis in all of the absolute, relative, and machine coordinate systems.   The remaining travel distance (DISTANCE TO GO) for each axis in the currently executed block of the program is also shown in the MEMORY or MDI mode.

```
ACTUAL POSITION          TEST        O 0 0 5 0      N 0 0 0 0 1
   (RELATIVE)        (ABSOLUTE)       (MACHINE)       (DISTANCE TO GO)
   X   0.000         X   0.000        X   0.000       X   0.000
   Y   0.000         Y   0.000        Y   0.000       Y   0.000
   Z   0.000         Z   0.000        Z   0.000       Z   0.000



        (MODAL)
G00  G35         F       M
G17  G97                 M
G90  G57         H       M
G21  G64         D       T
G40  G78                        F                        0 MM/M
G49             S                            PART COUNT       1234
            SACT  0        RUN TIME     12H34M  CYCLE TIME  0H03M16S

                           MEM **** *** ***        15 : 32 : 27
   |    |    |    |    |    | ABS | REL | [ALL] | HNDL | (OPRT) |
```

HANDLE INTERRUPTION display

Press the HNDL softkey to show the following items:

- INPUT UNIT: Axis travel in the CNC input unit system (mm or inch)
- OUTPUT UNIT: Axis travel in the handwheel control box output unit system (mm or inch)
- RELATIVE: Current axis position in the relative coordinate system
- DISTANCE TO GO: Remaining travel distance for each axis in the currently executed block of the program (shown only in the MEMORY and MDI modes)

```
HANDLE INTERRUPTION        TEST         O 0 0 5 0      N 0 0 0 0 1

   (INPUT UNIT)         (OUTPUT UNIT)      (RELATIVE)      (DISTANCE TO GO)
  X    0.000          X    0.000        X    0.000      X    0.000
  Y    0.000          Y    0.000        Y    0.000      Y    0.000
  Z    0.000          Z    0.000        Z    0.000      Z    0.000




         (MODAL)
 G00  G35        F         M
 G17  G97                  M
 G90  G57        H         M
 G21  G64        D         T
 G40  G78                          F                           0 MM/M
 G49             S                              PART COUNT        1234
              SACT  0             RUN TIME      12H34M  CYCLE TIME  0H03M16S

                                  MEM **** *** ***      15 : 32 : 27
 |    |    |    |    |   | ABS | REL | ALL | HNDL | (OPRT) |
```

Setting up ACTUAL POSITION displays

Reset PART COUNT as described below.

1   Press the OPRT softkey to change the softkey menu.

2   Press the PTSPRE softkey to blink PART COUNT.

3   Press the EXEC softkey to reset PART COUNT to zero.

Reset RUN TIME as described below.

1   Press the OPRT softkey to change the softkey menu.

2   Press the RUNPRE softkey to blink RUN TIME.

3   Press the EXEC softkey to reset RUN TIME to zero.

Preset the actual axis position in the relative coordinate system at zero as described below.

1   Press the REL or ALL softkey to select the ACTUAL POSITION (RELATIVE) or ACTUAL POSITION display.

2   Press the OPRT softkey to change the softkey menu.

3   Press the Origin softkey.

4   Key-in the address of an axis to preset its actual position at zero. The selected axis will blink.   Or press the ALL EXEC softkey to preset the actual positions of all axes at zero.

5   Press the EXEC softkey to preset the actual position of the selected axis at zero.

Preset the actual axis position in the relative coordinate system at an arbitrary value as described below.

1   Press the REL or ALL softkey to select the ACTUAL POSITION (RELATIVE) or ACTUAL POSITION display.

2   Press the OPRT softkey to change the softkey menu.

3   Key-in the address of an axis and coordinate value (X100, for example).   The selected axis will blink.

4   Press the PRESET softkey to preset the actual position of the selected axis at the specified value.

System displays

Press the System key to show a system display.   The AMADA engineer will use the system displays to perform maintenance or adjustment.

⚠ WARNING	● The system displays are used to handle parameters necessary for the correct operation of the machine. The parameters are usually protected. Do not change the contents of the displays; otherwise the machine may not correctly operate or deteriorate in accuracy.

Program displays

Press the Program key to show a program display.   Press an appropriate softkey in the variable area to select one of the six program displays described below.

PROGRAM display

Press the PRGRM softkey to show the PROGRAM display.   The PROGRAM display shows the contents of the currently called program. Each time the PRGRM softkey is pressed, the contents of the program are shown full-screen or in the variable area alone.   For the program editing methods, refer to Part IV, Program Management.

Divided screen

```
ACTUAL POSITION          TESTCUT      O 0 0 5 0        N 0 0 0 0 1

                 (ABSOLUTE)           F                       0 MM/M
      X             0 . 0 0 0                     PART COUNT        1234

      Y             0 . 0 0 0         RUN TIME        12H34M  CYCLE TIME  0H03M16S

      Z             0 . 0 0 0         ┌─────────────────────────────┐
                                      │ PROGRAM                      │
                                      │ O50 (TESTCUT) ;              │
                                      │ M102 (SPC1.0) ;              │
                                      │ G92  G90  X50  Y50 ;         │
         (MODAL)                      │ G93  X0  Y0 ;                │
   G00  G35       F        M          │ M100 ;                       │
   G17  G97                M          │ E002 ;                       │
   G90  G57       H        M          │ G00  G41  X25  Y25 ;         │
   G21  G64       D        T          │ M103 ;                       │
   G40  G78                           │ G01  X25  Y0 ;               │
   G49                                │ G00 ;                        │
                        S             │                              │
                  SACT  0             │  >_                          │
                                      └─ MEM **** *** ***    15 : 32 : 27 ┘

   │    │ ABS │ REL │ ALL │ HNDL │  ││ PRGRM │ MDI │    │ NEXT │(OPRT)│ + │
```

Full screen

```
   PROGRAM              TESTCUT       O 0 0 5 0        N 0 0 0 0 1

   O50 (TESTCUT) ;                    O50 (TESTCUT) ;
   M102 (SPC1.0) ;                    M102 (SPC1.0) ;
   G92  G90  X50  Y50 ;               G92  G90  X50  Y50 ;
   G93  X0  Y0 ;                      G93  X0  Y0 ;
   M100 ;                             M100 ;
   E002 ;                             E002 ;
   G00  G41  X25  Y25 ;               G00  G41  X25  Y25 ;
   M103 ;                             M103 ;
   G01  X25  Y0 ;                     G01  X25  Y0 ;
   G00 ;                              G00 ;




   >_
                                      EDIT **** *** ***      15 : 32 : 27

   │   │    │    │    │    │   │ PRGRM │ DIR │    │    │ (OPRT) │ + │
```

PROGRAM DIRECTORY display (only in EDIT mode)

Press the DIR softkey to show the PROGRAM DIRECTORY display full-screen. The program directory appears full-screen.

```
PROGRAM DIRECTORY        TEST        O 0 0 5 0        N 0 0 0 0 1
                                     .
                                     .
                                     : PROGRAM (NUM.)  MEMORY (CHAR.)
                                     USED:       61          142480
                                     FREE:      339          381680
00000001 (TASUUKODORI)               00000050 (TEST)
00000002 (BURAKET)                   00000098 (COVER-1/SPC/1.2)
00000003 (SEIHIN-A)                  00000100 (COVER-2/SPC/1.2)
00000004 (SEIHIN-B)                  00000108 (CM300)
00000005 (CNTRL-BOX)                 00000110 (PC200MK2)
00000006 (M1A1)                      00000112 (GAIDE-R)
00000007 (HANNBUNNGIRI)              00000116 (GAIDE-L)
00000008 (PC9801RA)                  00000998 (TENNBANN)
00000009 (BIGHORN)                   00000999 (LCA-TEST)
00000010 (GDYD-88)                   00001000 (SOKUBAN-R)
00000011 (BALLADE3)                  00001150 (SOKUBAN-L)
00000012 (PC-PR201X)                 00001200 (PLATE-1)
00000013 (LITTLEZFW)                 00001230 (PLATE-2)
>_                                   EDIT **** *** ***      15 : 32 : 27

 ◁                          PRGRM  DIR            (OPRT)  +
```

DIRECTORY (FLOPPY) display (only in EDIT mode)

Press the FLOPPY softkey to show the DIRECTORY (FLOPPY) display full-screen. For the methods of reading data from and writing data to the floppy disk, refer to Part IV, Program Management.

```
DIRECTORY (FLOPPY)                   O 0 0 5 0        N 0 0 0 0 1

NO.  FILE NAME           (METER) VOL NO.    FILE NAME      (METER) VOL






>_
                                     EDIT **** *** ***      15 : 32 : 27

           .                PRGRM      DIR       (OPRT)
```

PROGRAM (MDI) display (only in MDI mode)

Press the MDI softkey to show the PROGRAM (MDI) display.   This display is used to operate the machine in the MDI mode.

```
PROGRAM (MDI)
M81 ;
%




>_
MDI  ****  ***  ***        15 : 32 : 27
PRGRM  MDI           NEXT   (OPRT)  +
```
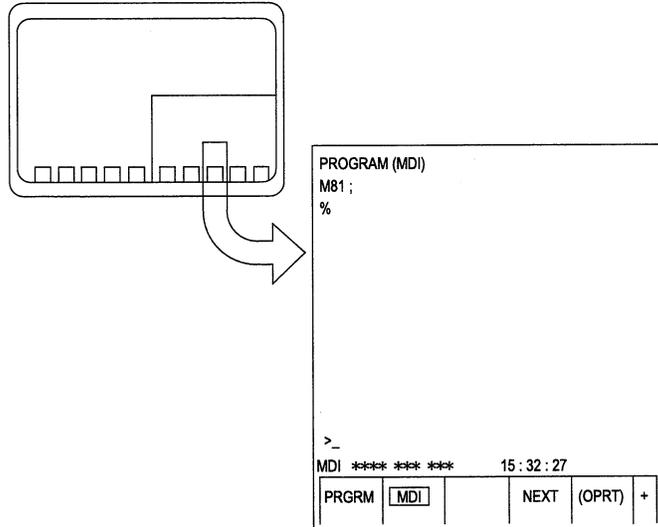
PROGRAM (NEXT BLOCK) display (in MEMORY, MDI, MANUAL, and RETRACT modes)

Press the NEXT softkey to show the PROGRAM (NEXT BLOCK) display.   This display is not used.

PROGRAM RESTART display (in MEMORY, MDI, MANUAL, and RETRACT modes)

Press the RSTR softkey to show the PROGRAM RESTART display. This display is not used.

NOTE

● Do not change the contents of the display.

Offset/setting displays

Press the Offset/Setting key to show an offset/setting display. Press an appropriate softkey in the variable area to select one of the 11 displays described below. Each time the Offset/Setting key is pressed, the softkey menu changes.

OFFSET display

Press the OFFSET softkey to show the OFFSET display full-screen.

```
OFFSET                            O 0 0 5 0      N 0 0 0 0 1

 NO.     DATA      NO.     DATA      ACTUAL POSITION (RELATIVE)
 001     0.010     017    0.170
 002     0.020     018    0.180      X          0 . 0 0 0
 003     0.030     019    0.190
 004     0.040     020    0.200      Y          0 . 0 0 0
 005     0.050     021    0.210
 006     0.060     022    0.220      Z          0 . 0 0 0
 007     0.070     023    0.230
 008     0.080     024    0.240
 009     0.090     025    0.250
 010     0.100     026    0.260
 011     0.110     027    0.270
 012     0.120     028    0.280
 013     0.130     029    0.290
 014     0.140     030    0.300
 015     0.150     031    0.310
 016     0.160     032    0.320

 >_
                              JOG  ****  ***  ***      15 : 32 : 27

 |   |   |   |   |   |  OFFSET | SETING | WORK |   | (OPRT) | +
```

SETTING display

Press the SETING softkey to show the SETTING display.
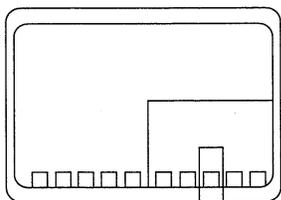
```
SETTING (HANDY)

PARAMETER  WRITE  = 1 (0 : DISABLE   1 : ENABLE)
TV  CHECK         = 0 (0 : OFF        1 : ON)
PUNCH  CODE       = 0 (0 : EIA        1 : ISO)
INPUT  UNIT       = 0 (0 : MM         1 : INCH)
I/O  CHANNEL      = 0 (0 - 3 : CHANNEL  NO.)
SEQUENCE  NO.     = 0 (0 : OFF        1 : ON)
TAPE  FORMAT      = 0 (0 : NO CNV     1 : F15)
SEQUENCE  STOP    =      0 (PROGRAM  NO.)
SEQUENCE  STOP    =      0 (SEQUENCE  NO.)




>_

  EDIT **** *** ***        15 : 32 : 27

  OFFSET  SETING   WORK         (OPRT)   +
```

WORK COORDINATES display

Press the WORK softkey to show the WORK COORDINATES display.
This display is not used.

_____
NOTE
_____

● Do not change the contents of the display.

VARIABLE display

Press the MACRO softkey to show the VARIABLE display.   This
display is used to enter user macro program data.

⚠ WARNING	● Do not change the contents of the display; otherwise the machine may not correctly operate or deteriorate in accuracy.

LASER POWER display

Press the POWER softkey to show the LASER POWER display.   This
display is used to show information about the current laser output.   The
items shown on the display are also shown on the LASER
INFORMATION display, an executor display.

LASER SETTING and TRACE SETTING displays

Press the SET softkey to show the LASER SETTING or TRACE
SETTING display.   These displays are not used.

NOTE

● Do not change the contents of the displays.

CUTTING and PIERCING displays

Press the DATA softkey to show the CUTTING or PIERCING display.
These displays are not used.

NOTE

● Do not change the contents of the displays; otherwise the cutting or piercing
   conditions set on the CUTTING CONDITION or PIERCING CONDITION
   display, an executor display, will be changed.
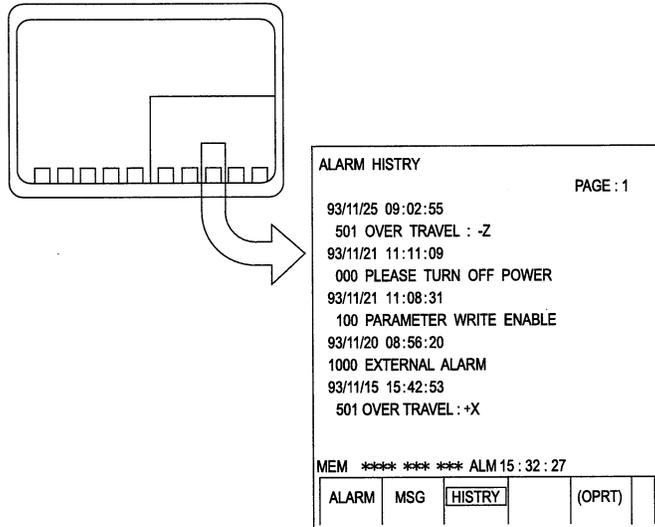
STATUS display

Press the STATUS softkey to show the STATUS display full-screen.
This display is used to show information about the current laser output.
The items shown on the display are also shown on the LASER
INFORMATION display, an executor display.

Message displays

Press the Message key to show a message display. Press an appropriate softkey in the variable area to select one of the three message displays described below.

ALARM HISTORY display

Press the HISTRY softkey to show the ALARM HISTORY display. The ALARM HISTORY display shows a maximum of 50 past CNC alarms. Each time a CNC alarm occurs, the oldest CNC alarm is deleted from the display. The date, time, and cause of each CNC alarm are shown on the display. Five alarms are shown per page. Press either of the Page keys to scroll between the pages of the display.

```
ALARM  HISTRY
                                         PAGE : 1

93/11/25  09:02:55
   501  OVER  TRAVEL : -Z
93/11/21  11:11:09
   000  PLEASE  TURN  OFF  POWER
93/11/21  11:08:31
   100  PARAMETER  WRITE  ENABLE
93/11/20  08:56:20
   1000  EXTERNAL  ALARM
93/11/15  15:42:53
   501 OVER TRAVEL : +X


MEM  ****  ***  ***  ALM 15 : 32 : 27
┌───────┬─────┬────────┬──────┬────────┬────┐
│ ALARM │ MSG │ HISTRY │      │ (OPRT) │    │
└───────┴─────┴────────┴──────┴────────┴────┘
```

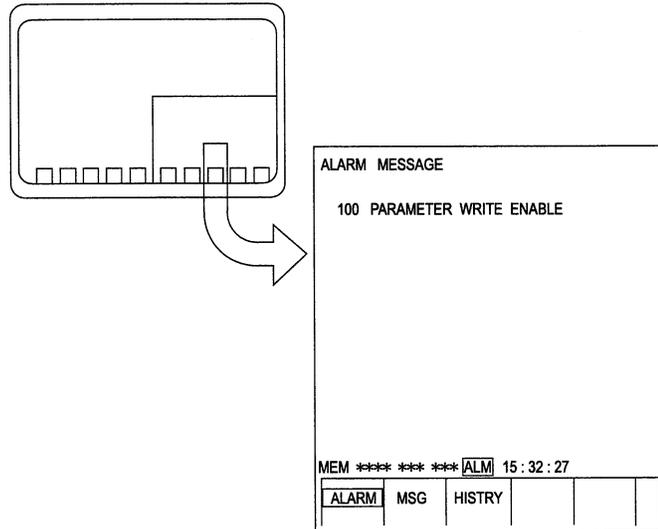Delete the contents of the alarm history as described below.

1 Press the OPRT softkey on the ALARM HISTORY display to change the softkey menu.

2 Press the CLEAR softkey to delete the contents of the alarm history.

ALARM MESSAGE display

Press the ALARM softkey to show the ALARM MESSAGE display. When a CNC alarm occurs, the corresponding alarm number and message are shown on the ALARM MESSAGE display.   For the detailed contents of alarms and the methods of clearing alarms, refer to Part V, Alarms.   When a CNC alarm is caused, the machine cannot be automatically operated.

```
ALARM  MESSAGE

   100  PARAMETER  WRITE  ENABLE




MEM **** *** *** ALM 15 : 32 : 27
ALARM  | MSG  | HISTRY |    |    |
```

OPERATOR MESSAGE display

Press the MSG softkey to show the OPERATOR MESSAGE display. When an operational prompt is generated, the prompt message is shown on the OPERATOR MESSAGE display.

```
OPERATOR  MESSAGE

   NO 2101
MEMORY  BACKUP  CELL  VOLTAGE  LOW




MEM **** *** *** ALM 15 : 32 : 27
ALARM  | MSG  | HISTRY |    |    |
```
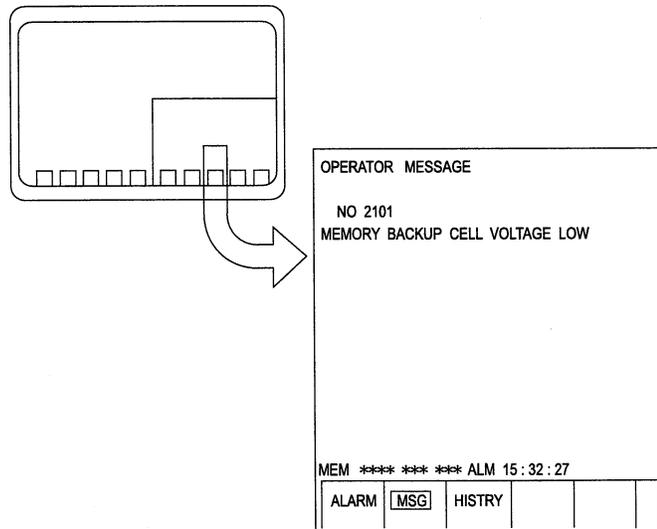
Help displays

Press the Help key to show the help function initial menu display. Press an appropriate softkey in the variable area to select one of the three help displays described below.

```
HELP (INITIAL MENU)


              ***** HELP *****


            1. ALARM DETAIL
            2. OPERATION METHOD
            3. PARAMETER TABLE




EDIT **** *** ***        15 : 32 : 27
ALARM  OPERAT PARAM
```

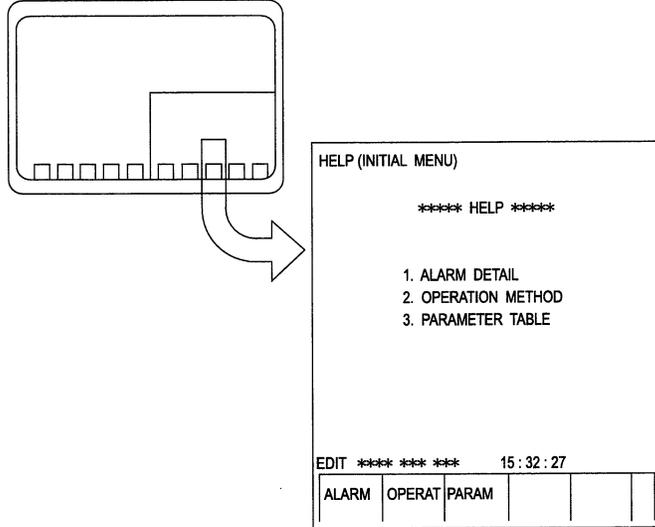## ALARM DETAIL display

Press the ALARM softkey to show the ALARM DETAIL display. When a CNC alarm is caused, its detail is described on the display. To show the description of another CNC alarm or when a CNC alarm is not currently caused, press the OPRT softkey, key-in the number for the CNC alarm, and press the SELECT softkey.

```
HELP (ALARM  DETAIL)

NUMBER: 000
MEAN: PLEASE TURN OFF POWER
FUNCTION:PARAMETER SETTING
ALARM:
  A PARAMETER WHICH REQUIRES THE POWER
  OFF WAS INPUT. TURN OFF POWER.



>_
EDIT **** *** ***        15 : 32 : 27
RE-SCR  PRIV.N  NEXT.N        SELECT
```
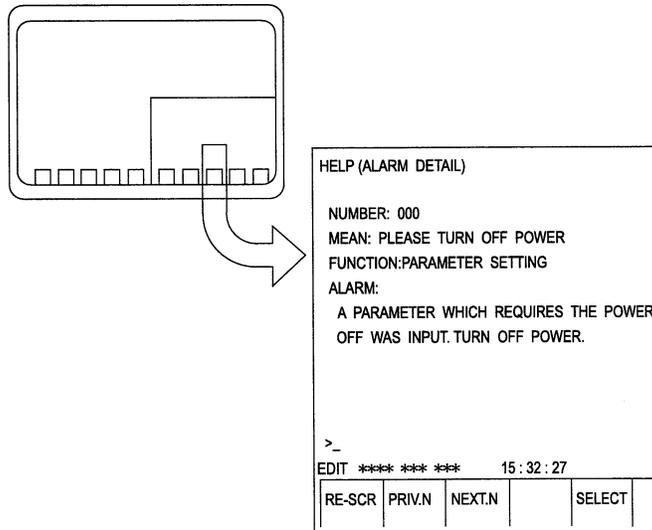
OPERATION METHOD display

Press the OPERAT softkey to show the OPERATION METHOD menu display.

```
┌─────────────────────────┐
│                         │
│                         │
│          ┌──────┐       │
│          │      │       │
│  ┌┐┌┐┌┐┌┐│┌┐┌┐┌┐│       │
└──┴┴┴┴┴┴┴┴┴┴┴┴┴┴┴┴───────┘
```

```
┌──────────────────────────────────────┐
│ HELP (OPERATION METHOD)                │
│                                        │
│  1. PROGRAM EDIT                       │
│  2. SEARCH                             │
│  3. RESET                              │
│  4. INPUT WITH MDI                     │
│  5. INPUT WITH TAPE                    │
│  6. OUTPUT                             │
│  7. INPUT WITH FANUC CASSETTE          │
│  8. OUTPUT WITH FANUC CASSETTE         │
│  9. MEMORY CLEAR                       │
│                                        │
│                                        │
│ EDIT **** *** ***      15 : 32 : 27    │
│ ┌─────┬──────┬─────┬────┬───────┐      │
│ │ALARM│OPERAT│PARAM│    │(OPRT) │      │
│ └─────┴──────┴─────┴────┴───────┘      │
└──────────────────────────────────────┘
```
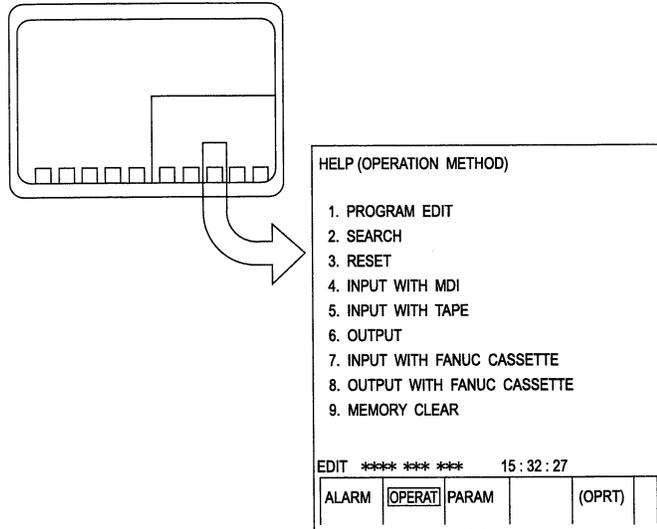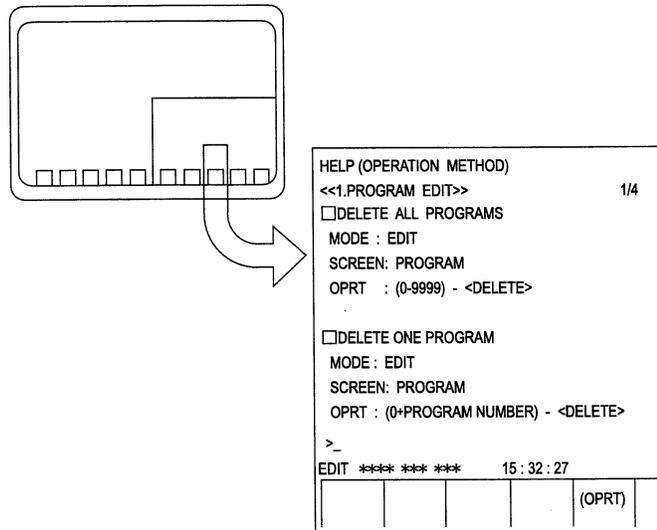
Key-in an appropriate number and press the SELECT softkey to show the description of the desired operation method.   The page number is shown at the upper right of the screen.   Press either of the Page keys to scroll between the pages of the display.

```
┌─────────────────────────┐
│                         │
│                         │
│          ┌──────┐       │
│          │      │       │
│  ┌┐┌┐┌┐┌┐│┌┐┌┐┌┐│       │
└──┴┴┴┴┴┴┴┴┴┴┴┴┴┴┴┴───────┘
```

```
┌──────────────────────────────────────┐
│ HELP (OPERATION  METHOD)               │
│ <<1.PROGRAM EDIT>>              1/4     │
│ □DELETE ALL PROGRAMS                   │
│  MODE : EDIT                           │
│  SCREEN: PROGRAM                       │
│  OPRT  : (0-9999) - <DELETE>           │
│                                        │
│                                        │
│ □DELETE ONE PROGRAM                    │
│  MODE : EDIT                           │
│  SCREEN: PROGRAM                       │
│  OPRT : (0+PROGRAM NUMBER) - <DELETE>  │
│                                        │
│ >_                                     │
│ EDIT **** *** ***      15 : 32 : 27    │
│ ┌────┬────┬────┬─────┬───────┐         │
│ │    │    │    │     │(OPRT) │         │
│ └────┴────┴────┴─────┴───────┘         │
└──────────────────────────────────────┘
```

PARAMETER TABLE display

Press the PARAM softkey to show the PARAMETER TABLE display.
Press either of the Page keys to scroll between the pages of the display.
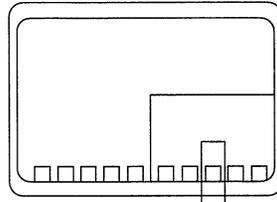
```
HELP (PARAMETER TABLE)
                                          1/4
☐ SETTING                      (NO.0000 - )
☐ READER/PUNCHER INTERFACE     (NO.0100 - )
☐ AXIS CONTROL
        / SETTING UNIT         (NO.1000 - )
☐ COORDINATE UNIT              (NO.1200 - )
☐ STROKE LIMIT                 (NO.1300 - )
☐ FEED RATE                    (NO.1400 - )
☐ ACCEL/DECELERATION CNTR      (NO.1600 - )
☐ SERVO RELATED                (NO.1800 - )
☐ DI/DO                        (NO.3000 - )


EDIT **** *** ***      15 : 32 : 27
 ALARM  OPERAT PARAM
```

EXECUTOR DISPLAYS

Processing condition files* and machine parameters are handled on the executor displays.

*A processing condition file consists of a cutting condition display, a piercing condition display and an edge cutting condition display, and classifies processing condition data by worksheet material and thickness and by cutting method.   Ten cutting conditions, three piercing conditions, and five edge cutting conditions can be set per processing condition file.   A maximum of 90 processing condition files can be registered in the CNC.

There are 9 executor displays as described below.

- LASER INFORMATION display: The current status of the machine is shown, and the cutting conditions can be changed during automatic operation.   The LASER INFORMATION display is shown as inserted in the right-hand half of the CUTTING CONDITION, PIERCING CONDITION, and EDGE CUTTING CONDITION displays.

- FILE LIST display: Material names (or processing condition file names) are called or registered.

- CUTTING CONDITION display: Cutting conditions are changed or registered.

- PIERCING CONDITION display: Piercing conditions are changed or registered.

- EDGE CUTTING CONDITION display: Edge cutting conditions are changed or registered.   The edge cutting conditions are not used.

- LASER PARAMETER display: Machine parameters are set.

- OVERRIDE display: Override multiplication rates of the cutting conditions used for operation are set.

- SYSTEM RUNNING display: Registered programs and pallet numbers are arranged in one schedule when the machine is equipped with the optional loading-unloading unit.

- AIV SETTING display: Several focal points are set to meet focal lengths of the lenses to be mounted and the optional OVS III is set up.

Press one of the Position, System, Program, Offset/Setting and Message keys to change from an executor display to a CNC display.

Press the Custom key to change from a CNC display to an executor display.   The executor display shown before the change to the CNC display will be shown again on the screen.

LASER INFORMATION display

The LASER INFORMATION display shows the current status of the machine in the right-hand half of the screen.

```
┌─────────────────────────────────────────────────────────────────────┐
│ [Mtrl name]  A50523.0              O0001          N0000               │
│ [Type]  A5052  [Thick. ]           [Mtrl name]  A50523.0              │
│ [Mtrl info] Std/Thick/Clean/Alumi  [Type] A5052        [Thick.] 3.00  │
│ [Wacs]      ON/OFF                 [Cond no.] E 3       [Mtrl info] Alumi │
│                                                                       │
│ Cut  Feed  Pwr. Freq. Duty  Gas   Gas                                 │
│      rate              Press. Kind                                    │
│ No.  [F]   [S]         [%]                                            │
│  1   500  2000  800   60   0.8    3    Feed     1 4 0 0 mm/m    1 0 0 % │
│  2  1000  2000 1600   90   0.8    3    Pwr.     2 0 0 0 W       1 0 0 % │
│  3  1000  2000 2000  100   0.8    3    Freq.    2 0 0 0 HZ      1 0 0 % │
│  4  1400  2000 2000  100   0.8    3    Duty     1 0 0 %         1 0 0 % │
│                                        Gas prs    0 . 8 0      1 0 0 % │
│  5    0     0    0    0    0.0    0                                    │
│  6    0     0    0    0    0.0    0    Gas kind     3    Gas time   1.0 │
│  7    0     0    0    0    0.0    0    Nozzl gap   1.0   Ofst (mm) 0.100 │
│  8    0     0    0    0    0.0    0    Focal(mm)   0.0   Pulse      0   │
│  9    0     0    0    0    0.0    0    Head        1     Pirc no.  101  │
│ [ Etch ]                                                              │
│ 10  3000   50 2000  100   3.0    3    X 1260.00  Z 65.00  Act. v 0 MM/M │
│ [   Feed Rate  ]  >                   Y 1260.00          Ave. pwr     │
│ ┌──┬────┬────┬────┬────┬────┐  ┌──────┬─────┬──────┬─────┬─────┬──┐   │
│ │< │    │    │    │Cut │Mtrl│  │Pierce│Edge │Select│Edit │Save │+ │   │
│ │  │    │    │    │Cond│List│  │      │     │      │     │     │  │   │
│ └──┴────┴────┴────┴────┴────┘  └──────┴─────┴──────┴─────┴─────┴──┘   │
└─────────────────────────────────────────────────────────────────────┘
┌──┬─────┬────┬────────┬─┬──────┬───┬───┬───┬──────┬──┐
│< │Param.│Over│Schedule│ │AIV   │   │   │   │All   │+ │
│  │     │ride│Data    │ │Setting│   │   │   │Repla.│  │
└──┴─────┴────┴────────┴─┴──────┴───┴───┴───┴──────┴──┘
```

1   When a CNC display is shown on the screen, press the Custom key to show an executor display. The executor display is the last executor display shown before the change to the CNC display.

2   On the FILE LIST display, press the Mtrl List softkey to show the LASER INFORMATION display. On the CUTTING CONDITION, PIERCING CONDITION, or EDGE CUTTING CONDITION display, press the Cut Cond. softkey to show the LASER INFORMATION display.

NOTE

● The LASER INFORMATION display cannot be shown on the LASER PARAMETER display.

3   Press the same softkey again to hide the LASER INFORMATION display. Press either of the Page keys to show the right-hand half of the original display covered by the LASER INFORMATION display.

The items shown on the LASER INFORMATION display are described below.

NOTE

● The override multiplication rates for the feed rate, laser output (power), pulse frequency and duty, and assist gas pressure can be changed by using the Override softkey function.

● Program number O: Shows the number of the currently called program.

- Sequence number N: Shows the number of the currently called sequence.
- Mtrl name: Shows the currently called material name (or processing condition file name).
- Type: Shows the material of the worksheet currently set.
- Thick: shows the thickness of the worksheet currently set.
- Cond. No: Shows the number of the currently selected cutting conditions (E code).
- Mtrl info: Shows the cutting method currently set.

  Std: Cutting of mild steel of less than 9.0 mm (0.35 in.) in thickness or ordinary cutting of stainless steel

  Thick: Cutting of mild steel of 9.0 mm (0.35 in.) or more in thickness

  Clean: Clean Cut of stainless steel

  Alumi: Cutting of aluminum

- Feed: Shows the feed rate [F] and the override multiplication rate [%].
- Pwr.: Shows the laser output [S] and the override multiplication rate [%].
- Freq.: Shows the pulse frequency [P] and the override multiplication rate [%].
- Duty: Shows the pulse duty [Q] and the override multiplication rate [%].
- Gas prs: Shows the assist gas pressure and the override multiplication rate [%]. 0 is shown when the machine is not equipped with assist gas pressure CNC control.
- Gas kind: Shows the type of the assist gas: 1 for low-pressure oxygen, 2 for medium-pressure oxygen, 3 for high-pressure oxygen, 4 for nitrogen, 5 for air and 7 for high-pressure nitrogen.
- Gas time: Shows the assist gas change time.
- Nozzl gap: Shows the distance from the worksheet surface to the nozzle tip when the machine is equipped with the Z-axis tracking sensor and the sensor is used.
- Ofst: Shows the compensation value for the laser beam path.
- Focal: Shows the focal point of the focusing lens when the machine is equipped with focal point CNC control.
- Pulse type: Shows the pulse type.
- Head: Shows the number of the laser bead to be used when the machine is equipped with an automatic head changer.
- Pirc no: Shows the currently set pierce number.
- Present position: Shows the current position of each machine axis in the absolute coordinate system.
- Act. V: Shows the actual axis travel speed.
- Ave. pwr: Not used.

FILE LIST display

The FILE LIST display is used to call or register material names (or processing condition file names).

```
┌──────────────────────────────────────────────────────────┐
│          [Mtrl name]                 [Mtrl name]           │
│  [Serch]   1. A50520.0              16. SPC2.3             │
│  ALL       2. A50521.5              17. SPC3.2             │
│  SPC/SPH   3. A50522.0              18. SPH4.5             │
│  SUS       4. A50523.0              19. SPH6.0             │
│  A         5. A-SUS1.0              20. SS4009.0           │
│  Others    6. A-SUS1.5              21. SS40012.0          │
│  Thickness 7. A-SUS2.0              22. SUS1.0             │
│  Std.      8. A-SUS3.0              23. SUS1.5             │
│  Thick     9. C-SUS1.0              24. SUS2.0             │
│  Clean    10. C-SUS1.5              25. SUS3.0             │
│  Alumi    11. C-SUS2.0              26. SUS4.0             │
│           12. C-SUS3.0              27. SUS5.0             │
│           13. SPC1.0                28. SUS6.0             │
│           14. SPC1.2                29. SUS8.0             │
│           15. SPC1.5                30. SUS10.0            │
│                                                            │
│  Rem. mtrl         50 Number                               │
│  Mtrl Name  A50523.0  ▌                                   │
│                                                            │
│  Open (Rename) (Copy)                                      │
└──────────────────────────────────────────────────────────┘
```

<				Cut Cont.	Mtrl List	Open	New			Search	+

<						Rename	Copy	Delete		All Repla.	+

1 When a CNC display is shown on the screen, press the Custom key to show an executor display.   The executor display is the last executor display shown before the change to the CNC display.

2 Press the Mtrl List softkey.

The items shown on the FILE LIST display are described below.

- Search: Shows one search condition in reverse video.
- Mtrl name (top of screen): Shows material names located by the search.
- Rem. mtrl: Shows the remaining material names that can be registered.   A maximum of 90 material names can be registered.
- Mtrl Name (bottom of screen): Shows the currently called material name.
- Open (Rename) (Copy): Shows the material name to be called, registered, changed, copied, or deleted.

Calling material name

Call a material name as described below.

1 Press the Cursor ↑, ↓, ←, and → keys to move the cursor (shown in white) to the material name to be called, or key-in the material name to be called.

NOTE

● When the keyed-in name is wrong, press the Cancel key and key-in the correct name.

2 Press the Input key.

3 Press the Open softkey.

NOTE

● When the specified material name is already called, it cannot be called again.

● When the specified material name is not registered, it cannot be called.

● Material names cannot be called during automatic operation.

Registering material name

Register a material name in the CNC memory as described below.

1 Key-in the material name to be registered in a maximum of 16 characters with the address, numeric, hyphen, and decimal point keys.

NOTE

● When the keyed-in name is wrong, press the Cancel key and key-in the correct name.

2 Press the Input key.

3 Press the New softkey to register the material name. The display changes to the CUTTING CONDITION display. When the cutting conditions for the material name are set and saved on the CUTTING CONDITION display, the registration of the material name is completed.

NOTE

● When the cutting conditions are not saved on the CUTTING CONDITION display, the material name is not registered.

● When the specified material name is already registered, it cannot be registered again.

● Material names cannot be registered during automatic operation.

Changing material name

Change a material name as described below.

1   Call the material name to be changed.

> **NOTE**
>
> ● When the name is already called, it need not be called again.

2   Key-in the new material name in a maximum of 16 characters with the address, numeric, hyphen, and decimal point keys.

> **NOTE**
>
> ● When the keyed-in name is wrong, press the Cancel key and key-in the correct name.

3   Press the Input key.

4   Press the Rename softkey to change the material name.

> **NOTE**
>
> ● When the specified new material name is already registered, it cannot be used.
> ● Material names cannot be changed during automatic operation.

Copying cutting conditions

Copy cutting conditions from a registered material name to a new material name as described below.

1   Call the material name from which the cutting conditions are to be copied.

> **NOTE**
>
> ● When the name is already called, it need not be called again.

2   Key-in the new material name to which the cutting conditions are to be copied in a maximum of 16 characters with the address, numeric, hyphen, and decimal point keys.

> **NOTE**
>
> ● When the keyed-in name is wrong, press the Cancel key and key-in the correct name.

3   Press the Input key.

4   Press the Copy softkey to copy the cutting conditions from the called material name to the new material name.

> **NOTE**
>
> ● When the specified material name is already registered, the cutting conditions cannot be copied to it.
> ● The cutting conditions cannot be copied during automatic operation.

Deleting material name

Delete a material name from the CNC memory as described below.

1 Press the Cursor ↑, ↓, ←, and → keys to move the cursor to the material name to be deleted, or key-in the material name to be deleted.

NOTE
● When the keyed-in name is wrong, press the Cancel key and key-in the correct name.

● The currently called material name cannot be deleted.

2 Press the Input key.

3 Press the Delete softkey to delete the material name.

NOTE
● Material names cannot be deleted during automatic operation.

● When a material name is deleted, its space is left blank in the list. When material names are sorted, the numbers for the material names following the blank space are advanced by one each. The material names can be sorted when ALL is specified in the search for material names.

Searching for material name

Search for a registered material name as described below.

1 Press the Search softkey.

2 Press a search condition softkey to start the search.

SPC·SPH: Material names with a mild steel (SPC or SPH) set at Type are searched for and shown.

SUS: Material names with a stainless steel (SUS) set at Type are searched for and shown.

A: Material names with a material starting with the letter A set at Type are searched for and shown.

Others: Material names with any other material set at Type are searched for and shown.

Thickness: Material names with the specified thickness set at Thick. are searched for and shown. Key-in the thickness and press the Input key after pressing the Thickness softkey.

Std: Material names with Std selected at Mtrl info are searched for and shown.

Thick: Material names with Thick selected at Mtrl info are searched for and shown.

Clean: Material names with Clean selected at Mtrl info are searched for and shown.

Alumi: Material names with Alumi selected at Mtrl info are searched for and shown.

ALL: All material names are shown.   When ALL is selected, press Y to alphabetically sort and show the material names or N to show them without sorting.

NOTE

● The material names cannot be searched for according to a combination of two conditions, such as SUS and thickness of 2.0.   Once a search is performed, the next search will be performed through all material names.

● The currently called material name is indicated by a green cursor.

Changing to another display

Press the Cut Cond. softkey to show the CUTTING CONDITION display.

Press the Mtrl List softkey to show or hide the LASER INFORMATION display.

Press the Param softkey to show the LASER PARAMETER display.

CUTTING CONDITION display

The CUTTING CONDITION display is used to show the cutting conditions set for the currently called material name (or processing condition file name).   The cutting conditions can be changed, registered, and selected on the display.

```
[Mtrl name] A50523.0                    [Pirc NO.] 101
[Type] A5052 [Thick. ]                  [Head] 1/2/3/4/5
[Mtrl info] Std/Thick/Clean/Alumi
[Wacs]     ON/OFF

Cut  Feed  Pwr.  Freq. Duty Gas  Gas   Gas  Nozzle Ofst  Edge Appr.  Focal Pulse
No.  rate              Press. Kind time  gap  [mm]  data data  [mm]  type
     [F]  [S]        [%]
 1   500  2000  800   60  0.8   3   1.0  1.0  0.100  201  205   0.0   0
 2  1000  2000 1600   90  0.8   3   1.0  1.0  0.100  202  205   0.0   0
 3  1000  2000 2000  100  0.8   3   1.0  1.0  0.100  201  205   0.0   0
 4  1400  2000 2000  100  0.8   3   1.0  1.0  0.100  203  205   0.0   0

 5     0     0    0    0  0.0   0   0.0  0.0  0.000    0    0   0.0   0
 6     0     0    0    0  0.0   0   0.0  0.0  0.000    0    0   0.0   0
 7     0     0    0    0  0.0   0   0.0  0.0  0.000    0    0   0.0   0
 8     0     0    0    0  0.0   0   0.0  0.0  0.000    0    0   0.0   0
 9     0     0    0    0  0.0   0   0.0  0.0  0.000    0    0   0.0   0
[ Etch ]
10  3000    50 2000  100  3.0   3   1.0  0.0  0.000    0    0   0.0   0
[  Feed Rate  ] >
```

<				Cut Cond.	Mtrl List		Pierce	Edge	Select	Edit	Save	+

<	Param.	Over ride	Schedule Data		AIV Setting					All Repla.	+

1   When a CNC display is shown on the screen, press the Custom key to show an executor display.   The executor display is the last executor display shown before the change to the CNC display.

2   On the FILE LIST display, press the Cut Cond. softkey to show the CUTTING CONDITION display.   On the PIERCING CONDITION or EDGE CUTTING CONDITION display, press the Return softkey to show the CUTTING CONDITION display.

The items shown on the CUTTING CONDITION display are described below.

- Mtrl name: Shows the currently called material name (or processing condition file name).   The name cannot be changed.

- Type: Sets the worksheet material.   The material is used as a search condition on the FILE LIST display.   Enter the material in a maximum of 8 characters with the address, numeric, hyphen, and decimal point keys.

- Thick.: Sets the worksheet thickness in the range of 0.00 to 999.99 mm (0.000 to 9.999 in.).   Be sure to set the thickness according to the thickness of the worksheet to be cut.

- Mtrl info: Selects the cutting method to be employed.

    Std: Cutting of mild steel of less than 9.0 mm (0.35 in.) in thickness or ordinary cutting of stainless steel

    Thick: Cutting of mild steel of 9.0 mm (0.35 in.) or more in thickness

    Clean: Clean Cut of stainless steel

    Alumi: Cutting of aluminum

- Wacs: Sets the water-assisted cutting system ON or OFF.   Not used when the machine is not equipped with the water-assisted cutting system.

- Pirc No: Sets one of the piercing conditions 101 to 103 on the PIERCING CONDITION display.

- Head: Sets the number of the laser head to be used in the range of 1 to 5 when the machine is equipped with an automatic head changer.

- Cut No.: Sets the cutting conditions at 1 to 9 and the scribing conditions at 10.   These numbers correspond to those used for the E code in the program.

- Feed rate: Sets the feed rate [F] in the range of 0 to 99999 mm/min (0 to 9999.99 in./min).

- Pwr.: Sets the laser output [S] in the range of 0 to 9999 W.

- Freq.: Sets the pulse frequency [P] in the range of 0 to 9999 Hz.

- Duty: Sets the pulse duty [Q] in the range of 0 to 100%.

- Gas prss.: Sets the assist gas pressure in the range of 0 to 2.55 MPa (0 to 25.5 kgf/cm^2).   Not used when the machine is not equipped with assist gas pressure CNC control.

- Gas kind: Sets the type of the assist gas to be used: 1 for low-pressure oxygen, 2 for medium-pressure oxygen, 3 for high-pressure oxygen, 4 for nitrogen, 5 for air and 7 for high-pressure nitrogen.

- Gas time: Sets the wait time after a piercing-to-cutting assist gas change in the range of 0 to 9.9 sec.

- Nozzl gap: Sets the distance from the worksheet surface to the nozzle tip in the range of 0.3 to 2.0 mm when the machine is equipped with the Z-axis tracking sensor and the sensor is used. Enter 0.3 when the worksheet is to be laser-cut by using the Clean-cut or Aluminum-cut accessory, and enter 1.5 for the ordinary nozzle unit.

- Ofst: Sets the compensation value for the laser beam path in the range of 0 to 9.999 mm (0 to 0.9999 in.).

- Edge data: Enter 0 for not selecting any of the edge cutting conditions 201 to 205 on the EDGE CUTTING CONDITION display and enter 201 to 205 for selecting one of the edge cutting conditions 201 to 205 on the EDGE CUTTING CONDITION display when changing the edge corner cutting conditions.

- Appr. data: Enter 0 for not selecting any of the edge cutting conditions 201 to 205 on the EDGE CUTTING CONDITION display and enter 201 to 205 for selecting one of the edge cutting conditions 201 to 205 on the EDGE CUTTING CONDITION display when changing the approach cutting conditions.

- Focal: Sets the focal point of the focusing lens in the range of –9.9 to +99.9 mm (–0.9999 to +9.999 in.) with respect to the reference focal point position (Focal point base pos.) on the LASER PARAMETER display.   Be sure to set at condition No. 1, irrespective of the cutting conditions selected.   Any other setting is disabled.   Not used when the machine is not equipped with focal point CNC control.

- Pulse type: Sets the pulse type in the range of 0 to 99.   Not used when the machine is not equipped with pulse waveform control.

- White cursor: Shows the data item that can be changed.

- Green cursor: Shows the currently selected conditions.

Selecting cutting conditions

Select the cutting conditions to be used as described below.   When the program has no E code, the machine cuts the worksheet according to the selected conditions.   When the program has an E code, the machine cuts the worksheet according to the E code-specified conditions.

1   Press the Select softkey to show a white cursor.

2   Press the Cursor ↑ and ↓ keys to move the cursor to the conditions to be used, or key-in the number for the conditions to be used.

3   Press the Input key.

NOTE

● Before pressing the Input key, press the Edit softkey to cancel the selection operation.

Changing data

Change the data as described below.

1   Press the Cursor ↑, ↓, ←, and → keys to move the cursor to the data to be changed.

2   Key-in new data with the numeric keys.

NOTE

● When the keyed-in data is wrong, press the Cancel key and key-in the correct data.

3   Press the Input key or the Cursor ↑, ↓, ←, or → key.

NOTE

● Press the Cursor ↑ key at condition No. 1 to move the cursor to Type. Press the Cursor ↓ key at condition No. 10 to move the cursor to condition No. 1.   If the keyed-in data is outside the specified range when one of the Cursor keys is pressed, the "Data error" message appears and the cursor does not move.

Copying data

Copy the data from the cursor position to all data below the cursor position as described below.

1   Press the Cursor ↑, ↓, ←, and → keys to move the cursor to the data to be copied.

2   Press the All Repla. softkey to change all the data below the cursor position, except for the scribing data (No. 10).

Saving data

Save the data as described below.

1   Press the Save softkey.

2   The "Has been saved" message appears to indicate that the new data has been saved.

NOTE

● The new data is shown on the display but must be saved to change the old data stored in the CNC memory.   If the new data is not saved, the old data will appear when the material name is called again.

● When the program is executed without saving the new data, the machine will cut the worksheet according to the old data if the program has the M102( ) block.

Changing to another display

Press the Cut Cond. softkey to show or hide the LASER INFORMATION display.

Press the Mtrl List softkey to show the FILE LIST display.

Press the Pierce softkey to show the PIERCING CONDITION display.

Press the Edge softkey to show the EDGE CUTTING CONDITION display.

Press the Param softkey to show the LASER PARAMETER display.

Press the right- or left-end arrowhead softkey and then the Override softkey to show the OVERRIDE display.

Press the right- or left-end arrowhead softkey and then the Schedule Data softkey to show the SYSTEM RUNNING display.

Press the right- or left-end arrowhead softkey and then the AIV Setting softkey to show the AIV SETTING display.

PIERCING CONDITION display

The PIERCING CONDITION display is used to change and register the piercing conditions.

[Mtrl name] A50523.0								[Pirc NO.] 101				
[Type] A5052 [Thick.]								[Head] 1/2/3/4/5				
[Mtrl info] Std/Thick/Clean/Alumi												
[Wacs] ON/OFF												
Pirc No.	Pwr. [S]	[Initial] freq.	[Initial] duty		[Step] time	cnt		Pirc time	[Assist gas] press kind		Gas time	Nozzle gap
101	2000	2000	100	0	0	0.0	0	3.0	1.0	1	0.0	0.0
102	0	0	0	0	0	0.0	0	0.0	0.0	0	0.0	0.0
103	0	0	0	0	0	0.0	0	0.0	0.0	0	0.0	0.0
Pirc No.	Focal [mm]	Pulse type										
101	0.0	0										
102	0.0	0										
103	0.0	0										
[Power] >												

<				Cut Cond.	Mtrl List		Return		Edit	Save	+

<	Param.	Over ride	Schedule Data		AIV Setting					All Repla.	+

1 When a CNC display is shown on the screen, press the Custom key to show an executor display. The executor display is the last executor display shown before the change to the CNC display.

2 On the FILE LIST display, press the Cut Cond. softkey to show the CUTTING CONDITION display. On the EDGE CUTTING CONDITION display, press the Return softkey to show the CUTTING CONDITION display.

3 On the CUTTING CONDITION display, press the Pierce softkey to show the PIERCING CONDITION display.

The items shown on the PIERCING CONDITION display are described below.

- Mtrl name: Shows the currently called material name (or processing condition file name). The name cannot be changed.

- Type: Sets the worksheet material. The material is used as a search condition on the FILE LIST display. Enter the material in a maximum of 8 characters with the address, numeric, hyphen, and decimal point keys.

- Thick.: Sets the worksheet thickness in the range of 0.00 to 999.99 mm (0.000 to 9.999 in.). Be sure to set the thickness according to the thickness of the worksheet to be cut.

- Mtrl info: Selects the cutting method to be employed.

  Std: Cutting of mild steel of less than 9.0 mm (0.35 in.) in thickness or ordinary cutting of stainless steel

  Thick: Cutting of mild steel of 9.0 mm (0.35 in.) or more in thickness

  Clean: Clean Cut of stainless steel

  Alumi: Cutting of aluminum

- Wacs: Sets water-assisted cutting system ON or OFF. Not used when the machine is not equipped with the water-assisted cutting system.

- Pwr.: Sets the laser output [S] in the range of 0 to 9999 W.

- Initial freq.: Sets the pulse frequency [P] in the range of 0 to 9999 Hz. When Thick is selected at Mtrl info, the initial pulse frequency is set for multiple-step piercing (or piercing under changing conditions).

- Initial duty: Sets the pulse duty [Q] in the range of 0 to 100%. When Thick is selected at Mtrl info, the initial pulse duty is set for multiple-step piercing.

- Increm freq.: Sets the pulse frequency increment for multiple-step piercing in the range of 0 to 9999 Hz when Thick is selected at Mtrl info. Set at 0 when multiple-step piercing is not performed.

- Increm duty: Sets the pulse duty increment for multiple-step piercing in the range of 0 to 100% when Thick is selected at Mtrl info. Set at 0 when multiple-step piercing is not performed.

- Step time: Sets the step time for the pulse frequency and duty increments for multiple-step piercing in the range of 0 to 9.9 sec when Thick is selected at Mtrl info. Set at 0 when multiple-step piercing is not performed.

- Step cnt: Sets the number of steps for the pulse frequency and duty increments for multiple-step piercing in the range of 0 to 99 when Thick is selected at Mtrl info. Set at 0 when multiple-step piercing is not performed.

- Pirc time: Sets the piercing time in the range of 0.1 to 99.9 sec.

- Assist gas prss.: Sets the assist gas pressure in the range of 0 to 2.55 MPa (0 to 25.5 kgf/cm^2). Not used when the machine is not equipped with assist gas pressure CNC control.

- Assist gas kind: Sets the type of the assist gas to be used: 1 for low-pressure oxygen, 2 for medium-pressure oxygen, 3 for high-pressure oxygen, 4 for nitrogen, 5 for air and 7 for high-pressure nitrogen.

- Gas time: Sets the wait time after a piercing-to-cutting assist gas change in the range of 0 to 9.9 sec.

- Nozzl gap: Sets the distance from the worksheet surface to the nozzle tip in the range of 0.3 to 2.0 mm when the machine is equipped with the Z-axis tracking sensor and the sensor is used. The default setting is 1.5 mm.

- Focal: Sets the focal point of the focusing lens in the range of −9.9 to +9.9 mm (−0.9999 to +9.999 in.) with respect to the reference focal point position (Focal point base pos.) on the LASER PARAMETER display. Be sure to set at condition No. 1, irrespective of the piercing conditions selected. Any other setting is disabled. Not used when the machine is not equipped with focal point CNC control.

- Pulse type: Sets the pulse type in the range of 0 to 99. Not used when the machine is not equipped with pulse waveform control.

- White cursor: Shows the data that can be changed.

- Green cursor: Shows the currently selected conditions.

Changing data

Change the data as described below.

1 Press the Cursor ↑, ↓, ←, and → keys to move the cursor to the data to be changed.

2 Key-in new data with the numeric keys.

> **NOTE**
>
> ● When the keyed-in data is wrong, press the Cancel key and key-in the correct data.

3 Press the Input key or the Cursor ↑, ↓, ←, or → key.

> **NOTE**
>
> ● Press the Cursor ↑ key at pierce No. 101 to move the cursor to Type. Press the Cursor ↓ key at pierce No. 103 to move the cursor to pierce No. 101.   If the keyed-in data is outside the specified range when one of the Cursor keys is pressed, the "Data error" message appears and the cursor does not move.

Copying data

Copy the data from the cursor position to all data below the cursor position as described below.

1 Press the Cursor ↑, ↓, ←, and → keys to move the cursor to the data to be copied.

2 Press the All Repla. softkey to change all the data below the cursor position.

Saving data

Save the data as described below.

1 Press the Save softkey.

2 The "Has been saved" message appears to indicate that the new data has been saved.

> **NOTE**
>
> ● The new data is shown on the display but must be saved to change the old data stored in the CNC memory.   If the new data is not saved, the old data will appear when the material name is called again.
>
> ● When the program is executed without saving the new data, the machine will cut the worksheet according to the old data if the program has the M102( ) block.

Changing to another display

Press the Cut Cond. softkey to show or hide the LASER INFORMATION display.

Press the Mtrl List softkey to show the FILE LIST display.

Press the Return softkey to show the CUTTING CONDITION display.

Press the Param softkey to show the LASER PARAMETER display.

Press the right- or left-end arrowhead softkey and then the Override softkey to show the OVERRIDE display.

Press the right- or left-end arrowhead softkey and then the Schedule Data softkey to show the SYSTEM RUNNING display.

Press the right- or left-end arrowhead softkey and then the AIV Setting softkey to show the AIV SETTING display.

EDGE CUTTING CONDITION display

The EDGE CUTTING CONDITION display is used to change and register the edge cutting conditions.

```
[Mtrl name] A50523.0
[Type] A5052 [Thick. ] 3.00
[Mtrl info] Std/Thick/Clean/Alumi
[Wacs]     ON/OFF
```

Edge no.	Work ang,	Pirc pwr.	Pirc freq.	Pirc duty	Pirc time	Pirc gas prss.	Pirc gas kind	[dis- tance	Recover feed rate	freq.	] duty
201	30	100	800	60	1.0	0.8	3	10.000	250	400	30
202	45	100	1200	60	1.0	0.8	3	10.000	500	800	45
203	60	100	1200	60	1.0	0.8	3	10.000	700	1000	50
204	0	0	0	0	0.0	0	0	0.000	0	0	0
205	0	0	0	0	0.0	0	0	0.000	500	1600	90

[Work angle]

<				Cut Cond.	Mtrl List		Return		Edit	Save	+

<	Param.	Over ride	Schedule Data		AIV Setting					All Repla.	+

1   When a CNC display is shown on the screen, press the Custom key to show an executor display.   The executor display is the last executor display shown before the change to the CNC display.

2   On the FILE LIST display, press the Cut Cond. softkey to show the CUTTING CONDITION display.   On the PIERCING CONDITION display, press the Return softkey to show the CUTTING CONDITION display.

3   On the CUTTING CONDITION display, press the Edge softkey to show the EDGE CUTTING CONDITION display.

The items shown on the EDGE CUTTING CONDITION display are described below.

- Mtrl name: Shows the currently called material name (or processing condition file name).   The name cannot be changed.

- Type: Sets the worksheet material.   The material is used as a search condition on the FILE LIST display.   Enter the material in a maximum of 8 characters with the address, numeric, hyphen, and decimal point keys.

- Thick.: Sets the worksheet thickness in the range of 0.00 to 999.99 mm (0.000 to 9.999 in.).   Be sure to set the thickness according to the thickness of the worksheet to be cut.

- Mtrl info: Selects the cutting method to be employed.

   Std: Cutting of mild steel of less than 9.0 mm (0.35 in.) in thickness or ordinary cutting of stainless steel

   Thick: Cutting of mild steel of 9.0 mm (0.35 in.) or more in thickness

   Clean: Clean Cut of stainless steel

   Alumi: Cutting of aluminum

- Wacs: Sets the water-assisted cutting system ON or OFF. Not used when the machine is not equipped with the water-assisted cutting system.
- Work ang.: Sets the edge angle for edge cutting in the range of 0 to 180°. When the edge angle is smaller than the value set here, the machine will cut the edges according to the edge cutting conditions.
- Pirc pwr.: Sets the laser output [S] for edge piercing in the range of 0 to 9999 W.
- Pirc freq.: Sets the pulse frequency [P] for edge piercing in the range of 0 to 9999 Hz.
- Pirc duty: Sets the pulse duty [Q] for edge piercing in the range of 0 to 100%.
- Pirc time: Sets the piercing time for edge piercing in the range of 0 to 99.9 sec.
- Pirc gas prss.: Sets the assist gas pressure for edge piercing in the range of 0 to 2.55 MPa (0 to 25.5 kgf/cm^2). Not used when the machine is not equipped with assist gas pressure CNC control.
- Pirc gas kind: Sets the type of the assist gas to be used for edge piercing: 1 for low-pressure oxygen, 2 for medium-pressure oxygen, 3 for high-pressure oxygen, 4 for nitrogen, 5 for air and 7 for high-pressure nitrogen.
- Recover distance: Sets the edge cutting distance in the range of 0 to 99.999 mm (0 to 9.9999 in.).
- Recover feed rate: Sets the feed rate [F] for edge cutting or approach cutting in the range of 0 to 7620 mm/min (0 to 300.00 in./min).
- Recover freq.: Sets the pulse frequency [P] for edge cutting or approach cutting in the range of 0 to 9999 Hz.
- Recover duty: Sets the pulse duty [Q] for edge cutting or approach cutting in the range of 0 to 100%.
- White cursor: Shows the data item that can be changed.

Changing data

Change the data as described below.

1 Press the Cursor ↑, ↓, ←, and → keys to move the cursor to the data to be changed.

2 Key-in new data with the numeric keys.

NOTE

● When the keyed-in data is wrong, press the Cancel key and key-in the correct data.

3 Press the Input key or the Cursor ↑, ↓, ←, or → key.

NOTE

● Press the Cursor ↑ key at edge No. 210 to move the cursor to Type. Press the Cursor ↓ key at edge No. 205 to move the cursor to edge No. 201. If the keyed-in data is outside the specified range when one of the Cursor keys is pressed, the "Data error" message appears and the cursor does not move.

Copying data

Copy the data from the cursor position to all data below the cursor position as described below.

1   Press the Cursor ↑, ↓, ←, and → keys to move the cursor to the data to be copied.

2   Press the All Repla. softkey to change all the data below the cursor position.

Saving data

Save the data as described below.

1   Press the Save softkey.

2   The "Has been saved" message appears to indicate that the new data has been saved.

> **NOTE**
>
> ● The new data is shown on the display but must be saved to change the old data stored in the CNC memory.   If the new data is not saved, the old data will appear when the material name is called again.
>
> ● When the program is executed without saving the new data, the machine will cut the worksheet according to the old data if the program has the M102( ) block.

Changing to another display

Press the Cut Cond. softkey to show or hide the LASER INFORMATION display.

Press the Mtrl List softkey to show the FILE LIST display.

Press the Return softkey to show the CUTTING CONDITION display.

Press the Param softkey to show the LASER PARAMETER display.

Press the right- or left-end arrowhead softkey and then the Override softkey to show the OVERRIDE display.

Press the right- or left-end arrowhead softkey and then the Schedule Data softkey to show the SYSTEM RUNNING display.

Press the right- or left-end arrowhead softkey and then the AIV Setting softkey to show the AIV SETTING display.

LASER PARAMETER display

The LASER PARAMETER display is used to set the machine parameters.

```
┌─────────────────────────────────────────────────────────┐
│  Laser  Parameter         Ver    1.00                     │
│                                                           │
│  Follow start.height          [      ] mm                │
│  Z retract H  No  end         [  5.000 ] mm              │
│               M00             [ 75.000 ] mm              │
│               M01             [ 75.000 ] mm              │
│               Chute           [ 25.000 ] mm              │
│  Assist gas open height       [ 10.000 ] mm              │
│  Cl,Al,Pirc · height          [  1.200 ] mm              │
│  Focal point base pos.        [ 10.000 ] mm              │
│  Wacs · off time              [   2.0  ] Sec             │
│                                                           │
│                                                           │
│ ┌──┬──┬──┬──┬──┐ ┌──┬──┬──┬─────┐                        │
│ │  │  │  │  │  │ │  │  │  │ End │                        │
└─────────────────────────────────────────────────────────┘
```

1 When a CNC display is shown on the screen, press the Custom key to show an executor display. The executor display is the last executor display shown before the change to the CNC display.

2 Press the Param softkey.

The items shown on the LASER PARAMETER display are described below.

- Follow start height: Sets the height at which the Z-axis tracking sensor is enabled when the machine is equipped with the Z-axis tracking sensor. Set the height from the worksheet surface. Not used when the machine is not equipped with the Z-axis tracking sensor.

- Z retract H: For each program end command, sets the height to which the laser head retracts (or rises) after cutting. Set the height from the worksheet surface.

    No end: Sets the laser head retract height when the M104 command is not entered.

    M00: Sets the laser head retract height when the machine stop command (M104 M00) is entered.

    M01: Sets the laser head retract height when the optional stop command (M104 M01) is entered.

    Chute: Not used.

NOTE

● When the worksheet thickness plus the laser head retract height plus the offset Z (G93 Z__) is greater than the maximum laser head (Z-axis) travel range, an alarm will occur during the execution of the program.

- Assist gas open height: Sets the height at which the assist gas is discharged. Set the height from the worksheet surface.

- Cl, Al, Pirc. height: Sets the amount by which the laser head rises for piercing during Clean Cut or Aluminum Cut. Set an increment from the nozzle tip-to-worksheet distance of 0.3 mm for cutting.

- Focal point base pos.: Sets the reference position for the focal point of the focusing lens. The focal point moves according to the data set at Focal on the CUTTING CONDITION or PIERCING CONDITION display when the machine is equipped with focal point CNC control and M100 is commanded. Not used when the machine is not equipped with focal point CNC control.

- Wacs·OFF time: Sets the time from the stop of the laser beam emission and cutting assist water spray to the stop of the assist gas when the worksheet is cut with the water-assisted cutting system. Not shown when the machine is not equipped with the water-assisted cutting system.

Setting data

Set the data as described below.

⚠ WARNING	● Do not enter a minus value; otherwise the machine cannot correctly operate.
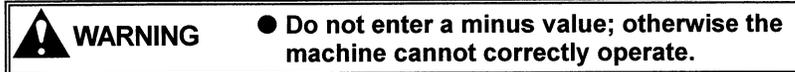
1   Move the cursor (white) to the position where the new data is to be entered.

2   Key-in the new data with the numeric keys.

NOTE

● When the keyed-in data is wrong, press the Cancel key and key-in the correct data.

3   Press the Input key.

Returning to last display

Press the End softkey to return to the last display.

OVERRIDE display

The OVERRIDE display is used to fine-tune the cutting conditions called from a processing condition file by overriding the "Feed," "Pwr.," "Freq.," "Duty," or "Gas prs" item.

Showing OVERRIDE display

On the current status display of the CUTTING CONDITION, PIERCING CONDITION, or EDGE CUTTING CONDITION display, press the right- or left-end arrowhead softkey to show the Override softkey.   Press the Override softkey to change to the OVERRIDE display.

```
[Mtrl name] A50523.0                    O0001         N0000
[Type] A5052 [Thick. ]                  [Mtrl name] A50523.0
[Mtrl info] Std/Thick/Clean/Alumi       [Type] A5052        [Thick.] 3.00
[Wacs]    ON/OFF                        [Cond no.] E  3     [Mtrl info] Alumi

Cut  Feed  Pwr. Freq. Duty  Gas   Gas
     rate              Press. Kind
No.  [F]   [S]        [%]                Feed     1 4 0 0 mm/m    1 0 0 %
1    500   2000 800   60    0.8   3      Pwr.     2 0 0 0 W       1 0 0 %
2    1000  2000 1600  90    0.8   3      Freq.    2 0 0 0 HZ      1 0 0 %
3    1000  2000 2000  100   0.8   3      Duty     1 0 0 %         1 0 0 %
4    1400  2000 2000  100   0.8   3      Gas prs  0 . 8 0         1 0 0 %

5    0     0    0     0     0.0   0      Gas kind    3     Gas time   1.0
6    0     0    0     0     0.0   0      Nozzl gap   1.0   Ofst (mm)  0.100
7    0     0    0     0     0.0   0      Focal(mm)   0.0   Pulse      0
8    0     0    0     0     0.0   0      Head        1     Pirc no.   101
9    0     0    0     0     0.0   0
[ Etch ]                                 X 1260.00  Z 65.00   Act. v  0 MM/M
10   3000  50   2000  100   3.0   3      Y 1260.00            Ave. pwr
[   Feed Rate   ]  >

 <  | Back | Cancel | 1/10 | Up | Down |  Feed | Power | Freq | Duty | Gas Prs | +
```

Cutting condition selection softkeys (Feed, Power, Freq, Duty, and Gas Prs)

Pressed to select one of the cutting conditions "feed rate," "laser output (power)," "pulse frequency," "pulse duty," and "assist gas pressure." The selected cutting condition is shown in yellow characters and its override multiplication rate can be changed.   When the CNC is turned on, the cutting condition selected last time is shown in yellow characters. The assist gas pressure is an optional cutting condition and can be selected only when the machine is equipped with assist gas CNC control.

The override multiplication rate for each cutting condition is as follows:

- Feed rate: 0 to 254 %
- Laser output (power): 0 to 200 %
- Pulse frequency: 0 to 200 %
- Pulse duty: 0 to 150 %
- Assist gas pressure: 0 to 200 %

1/10 softkey

Pressed to select the increment of the multiplication rate for a cutting condition to override.

Cutting condition shown in white characters: The override multiplication rate can be regulated in 10 % increments.

Cutting condition shown in yellow characters: The override multiplication rate can be regulated in 1 % increments.   However, the multiplication rate for the pulse duty cannot be regulated in 1 % increments.

Cancel softkey

Pressed to cancel the override multiplication rate of the selected cutting condition and to return to 100 %.

Up softkey

Pressed to increase the override multiplication rate of the selected cutting condition.

Down softkey

Pressed to decrease the override multiplication rate of the selected cutting condition.

Back softkey

Pressed to return to the original display.

SETTING (JOB SCHEDULE) display

Used for the scheduled operation when the machine is equipped with the optional loading-unloading unit. The method of setting data somewhat varies with the type of the loading-unloading unit installed. For details, refer to the operator's manual of the loading-unloading unit.

- JOB: The order of jobs is numerically listed. The numbers of the program and shelf, and the quantity of worksheets to be cut are set for each job.
- PROGRAM: The number of the program to be executed is set.
- SHEET: The quantity of worksheets to be cut is set.
- SHELF 1: The number of the worksheet shelf to be used is set.
- SHELF 2: The number of the part shelf to be used is set.
- RESERVED: Used when it is necessary to set the loading-unit vacuum pad position.

```
SETTING (JOB SCHEDULE)                            O1234     N56789
JOB PROGRAM SHEET SHELF SHELF RESER  JOB PROGRAM SHEET SHELF SHELF RESER
                   1     2    VED                        1     2    VED
01                                   14
02                                   15
03                                   16
04                                   17
05                                   18
06                                   19
07                                   20
08                                   21
09                                   22
10                                   23
11                                   24
12                                   25
13                                   26
                                         JOB      DONE      REMAIN
```

Entering data

1 Move the cursor with the Cursor ↑, ↓, ←, and → keys to the data item whose value is to be entered.

2 Key-in the value with the address and numeric keys.

3 Press the Input key to store the value in memory.

ALL CLEAR softkey

Pressed to clear all of the scheduled data.

QUIT softkey

Pressed to return to the original display.

Most of the items shown on the AIV SETTING display are used for the optional OVS III. Refer to the operator's manual of OVS III.

AIV SETTING display

Most of the items shown on the AIV SETTING display are used for the optional OVS **III**.   Refer to the operator's manual of OVS **III**.

Even when the machine is not equipped with the OVS **III** option, the "Focal point" item alone is used if the "Per-head focal point" setting function is set at ON.   If you need to enable or disable the "Per-head focal point" setting function, contact the AMADA engineer.

* Focal point: When the "Per-head focal point" setting function is set at ON, several focal point data can be stored in memory to meet focal lengths of the lenses to be mounted on the laser head.   An appropriate focal point data can be selected with the "Head" number in the processing condition file.

Entering data

1   Move the cursor with the Cursor ↑, ↓, ←, and → keys to the data item whose value is to be changed.

2   Key-in a new value with the address and numeric keys.

3   Press the Input key or one of the Cursor keys to store the new value in memory.

Setting initial value of data

Press the Initial Data softkey to return all of the focal point data to the initial value of 10.000 (mm).

NOTE

● Pressing the Initial Data softkey returns all settings on this display to their initial values.   This should be kept in mind when using OVS **III**.

Changing to another display

Press the Quit softkey to return to the original display.

Part III

Operation

PREPARATION PROCEDURE

The preparation procedure for a laser cutting operation is described in this section.

Be sure to inspect the machine before starting the day's work (see Part VI, Maintenance) and then prepare the machine for the operation.

⚠ WARNING	● When working inside the hazardous area around the machine, press the STOP buttons on the CNC control panel and the shuttle table control panel. Then turn the SHUTTER keyswitch to OFF, remove the key from the switch, and hold it by yourself — to prevent the machine from being started by mistake. ● Clear the hazardous area around the machine of people and obstacles before starting the machine — to prevent injuries and accidents.

⚠ CAUTION	● The goggles are only designed to protect beams of a specific range of waves. Check then that the type of goggles is adapted to the length of wave specific to the CO_2 laser, that is 10.6 μm. This value is given on the signal plates fixed on the source and on the laser head (see layout plan). ● When closing the workclamps using the free-motion bearing pallet, keep your hands away from the workclamps.

Setting up the machine

Set up the machine for operation as described below:

⚠ CAUTION	● Do not touch the lens surfaces when handling the lens.

NOTE

● Never turn on the circuit breaker switch on the electrical control unit before turning on the circuit breaker switch on the laser oscillator.

1   Turn on the shop circuit breaker switch.

2   Confirm that the cooling unit is turned on.

3   Confirm that the LASER keyswitch and the SHUTTER keyswitch are turned to OFF.

4   Supply the required compressed air to the machine, and unlock and open the intake valve of the air system. Then confirm that the pressure gauge for the system's air regulator indicates 0.5 MPa (5 kgf/cm^2).

5   Turn on the circuit breaker switch on the transformer box.

6   Unlock and turn on the circuit breaker switch on the laser oscillator.

7   Unlock and turn on the circuit breaker switch on the electrical control unit.

8   Press the POWER ON (I) button on the CNC control panel.

9   Press the ALARM RESET button for several seconds.

10   Press the SAFETY DEVICE RESET button, turning on the SAFETY DEVICE READY light.

11   Return all the machine axes to their origins — see "Manual operations" later in this Part for the procedure. Then shift the Y-axis to the end opposite to the origin, and lower the Z-axis to a position about 150 mm above the machine table in the MANUAL mode.

12   Check the interlocks and other devices for proper operation — see "Checking interlocks and other devices for proper operation" later in this Part for the procedure.

13   Open the partition doors — the SAFETY DEVICE READY light should then go out.

14 Mount the lens on the laser head as follows:

LOCK BAR

SENSOR CABLE
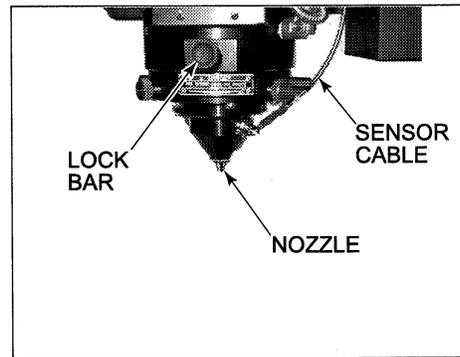
NOZZLE

(1) Disconnect the Z-axis tracking sensor cable from the nozzle unit.

(2) Pull out the nozzle unit lock bar on the laser head and detach the unit by turning it counterclockwise (viewed from the bottom).

(3) Mount the lens by turning it clockwise.

(4) Replace the nozzle unit by turning it clockwise and then push in the lock bar.

(5) Connect the Z-axis tracking sensor cable to the nozzle unit.

(6) Close the partition doors.

15 Open the main and stop valves of the laser gas cylinder. Then confirm that the secondary pressure gauge for the cylinder regulator indicates 0.15 to 0.2 MPa (1.5 to 2 kgf/cm^2) — adjust the pressure by using the regulator, if necessary.

16 Open the main valve of the assist gas cylinder to be used. Then confirm that the pressure gauge on the evaporator outlet indicates a total of 0.2 MPa (2 kgf/cm^2) plus the pressure required for cutting — adjust the pressure if necessary.

NOTICE

● Never set the assist gas pressure exceeding 1.2 MPa (12 kgf/cm^2) to protect the pipe inside the machine against bursting. When high-pressure nitrogen gas is used as assist gas, do not set its pressure exceeding 2.5 MPa (25 kgf/cm^2).

17 Turn the LASER keyswitch to ON — the LASER READY light will blink. When the LASER READY light comes on, the HIGH VOLTAGE light will start blinking. The laser oscillator will be ready for operation when the HIGH VOLTAGE light comes on.

III-4

Checking interlocks and other devices for proper operation

Interlocks

Check interlocks for proper operation.

The machine uses interlocked partition doors.　Check the interlocks for proper operation as described below.

If other interlocks are used, refer to their operator's manual.　If there are two or more interlocks, check all of them for proper operation.　If an interlock does not operate, discontinue the use of the machine and contact AMADA.

1　Check that the SAFETY DEVICE READY light is turned on.

2　Open the partition door by hand to operate the interlock, and check that the SAFETY DEVICE READY light goes out and the ALARM light comes on.

3　Return the interlock to the original condition and press the SAFETY DEVICE RESET button.　Check that the SAFETY DEVICE READY light comes on and the ALARM light goes out.

EMERGENCY STOP buttons

Check the EMERGENCY STOP buttons for proper operation.

Make this operational check on all EMERGENCY STOP buttons.

If an EMERGENCY STOP button does not operate, discontinue the use of the machine and contact AMADA.

1　Press the EMERGENCY STOP button.　Check that the EMERGENCY STOP button is locked in the pushed condition, the ALARM light comes on, and "EMG" appears on the screen.

2　Unlock the EMERGENCY STOP button.　Check that the ALARM light goes out and "EMG" disappears from the screen.

Setting the worksheet

When the schedule operation is to be performed in the MEMORY mode according to a scheduled series of programs, load a worksheet on each shuttle table pallet. (For the pallet handling and worksheet loading procedures, refer to the separate shuttle table manual.)

When the single operation is to be performed in the MEMORY or MDI mode by using one program, set a worksheet on the machine table as described below:

1   Return all the machine axes to their origins — see "Manual operations" later in this Part for the procedure.

2   Open the partition doors — the SAFETY DEVICE READY light should then go out.

3   Place the worksheet on the machine table.

4   Position the worksheet by pressing it against the locate pins.

5   Set the worksheet on the table by utilizing the bolt holes in the table, or close the workclamps (optional) to clamp the worksheet.

6   Close the partition doors.

Setting the assist gas pressure

When the optional assist gas CNC control is not provided, determine and set the assist gas pressure according to the worksheet material and thickness and the cutting condition as described below:

1   Return all the machine axes to their origins — see "Manual operations" later in this Part for the procedure.
    Move the head to the position where the assist gas pressure gauge of the head is seen.

2   Open the partition doors — the SAFETY DEVICE READY light should then go out.

3   Turn the assist gas selection switch to the position for the assist gas to be used. The assist gas will then be discharged and its pressure can be read on the pressure gauge on the laser head.

4   Pull out the knob in the position in which the switch is turned and turn the knob to obtain the required pressure.

5   Push in the knob and return the switch to AUTO.

6   Close the partition doors.

Calibrating the Z-axis tracking sensor

It is necessary to calibrate the nozzle gap and output signal of the Z-axis tracking sensor when:

- The sensor nozzle is changed.

- The sensor cone is changed.

- The sensor cable is changed.

- The Z-axis command value for tracking is different from the actual nozzle gap by more than the control tolerances of ±0.2 mm.

NOTICE

● The calibration program starts the sensing procedure when the laser head lowers to the height of Z=25 mm.   Do not calibrate the Z-axis tracking sensor using a work or jig exceeding the surface height of Z=25 mm.   Otherwise the laser head may strike against the work and damage itself and the work.

NOTE

● The calibration program is being executed until the light of the START button goes out.   If the Reset key or STOP button is pressed before the light of the START button goes out, the data will be cleared, disabling the correct completion of the calibration.

● When calibrating the Z-axis tracking sensor, use a worksheet of mild steel that is 2.3 mm or more in thickness and large enough with respect to the nozzle hole diameter.

● When an alarm is caused during the calibration, check the nozzle and sensor cable for looseness and the nozzle for contamination and restart the calibration procedure.

Standard sensor

Calibrate the standard Z-axis tracking sensor as described below.

1   Set the worksheet on the machine table — see "Setting the worksheet" earlier in this section for the procedure.

2   Clear the hazardous area of people and obstacles.

3   Press the SAFETY DEVICE RESET button, turning on the SAFETY DEVICE READY light.

4   Turn the MODE keyswitch to ON and change the CNC mode to MANUAL.

5   Move the laser head to a position above the worksheet.

6   Lower the laser head (Z-axis) to a position about 10 mm above the worksheet.

7   Change the CNC mode to MEMORY and return the MODE keyswitch to OFF.

8   Press the START button to execute the calibration program O8001.

     The laser head automatically lowers and touches the worksheet.
     It returns up and the program halts.   The machine coordinates will
     become Z 0.2 mm.

9   Turn the ORIGIN knob to adjust the voltage display to 8.9 V.   If the
     NEAR LED (red) comes on, make the voltage adjustment to turn
     off the LED.   (Adjust the voltage as close to 8.9 V as you can
     while keeping the LED off.)

10   Press the START button.   The machine coordinates will become Z
     2.98 mm.

11   Adjust the voltage display to −8.9 V with the GAIN knob.

12   Press the START button.   The machine coordinates will become Z
     1.5 mm.

13   Adjust the voltage display to ±0.0 V with the LINEAR knob.

14   Press the START button.

     Repeat Steps 8 to 14 so that the voltage at each position stays
     within ±0.02V.   (If you cannot adjust the voltage within ±0.02 V
     after a few attempts, ±0.05 V will do.)

15   After the voltage adjustment is completed, press the Reset key.

16   Turn the MODE keyswitch to ON, change the CNC mode to
     RETRACT, and zero-return the Z-axis.

17   Open the partition doors — the SAFETY DEVICE READY light
     should then go out.

18   Remove the worksheet.

NOTE

● If the system does not follow properly, make sure that the nozzle is clean and
  snugly fitted.   Re-calibrate from Step 6.

● The system may have troubles unless the Z-axis is zero-returned after the
  calibration.

Optional HS98 sensor

Calibrate the optional HS98 Z-axis tracking sensor as described below.

1   Set the worksheet on the machine table — see "Setting the worksheet" earlier in this section for the procedure.

2   Clear the hazardous area of people and obstacles.

3   Press the SAFETY DEVICE RESET button, turning on the SAFETY DEVICE READY light.

4   Turn the MODE keyswitch to ON and change the CNC mode to MANUAL.

5   Press the TRACE OFF button to turn on its light.

6   Move the laser head to a position above the worksheet.

7   Change the CNC mode to MEMORY and return the MODE keyswitch to OFF.

8   Turn the SHUTTER keyswitch to ON.

9   Press the START button to execute the calibration program O8010.

   The laser head rapids down to the height of Z=25 mm and then slowly lowers from there into contact with the worksheet.

   After the calibration, the Z-axis is automatically zero-returned.

10   This completes the laser head motion and is followed by the writing of data.   The writing operation takes about 10 sec.

11   The light of the START button goes out to indicate the end of the calibration.   The entire procedure takes about 30 to 40 sec.

12   Press the TRACE OFF button to turn off its light.

13   Open the partition doors — the SAFETY DEVICE READY light should then go out.

14   Remove the worksheet.

Centering the nozzle unit

Center the nozzle unit as described below when preparing the machine for a laser cutting operation.

1 The procedure requires a stainless steel sheet with a thickness of 0.5 to 1.0 mm. And the following program is needed — the dimensional data are in millimeters:

```
O7000(NOZZLE CENTER) ;
M100 ;
#32=1. ;
IF[#4006NE20.] GOTO1 ;
#32=25.4 ;
N1 G00 Z[25./#32] ;
G31 P5 T1 ;
G24 S300 P100 Q50 R.3 ;
M101 ;
G00 Z[100./#32] ;
M30 ;
```

2 Set the worksheet on the machine table — see "Setting the worksheet" earlier in this section for the procedure.

3 Clear the hazardous area of people and obstacles.

4 Press the SAFETY DEVICE RESET button, turning on the SAFETY DEVICE READY light.

5 Turn the MODE keyswitch to ON and change the CNC mode to MANUAL.

6 Position the worksheet for piercing by shifting the X-axis and the Y-axis manually.

7 Change the CNC mode to MEMORY and return the MODE keyswitch to OFF.

8 Turn the SHUTTER keyswitch to ON.

9 Press the START button to execute the program.

10 When the machine is stopped by the M30 command, turn the SHUTTER keyswitch to OFF.

11 Turn the MODE keyswitch to ON and change the CNC mode to MANUAL.

12 Shift the Y-axis to the end opposite to the origin, and lower the Z-axis to a position about 150 mm above the machine table so that adjustment can be made in Step 15 below.

13 Open the partition doors — the SAFETY DEVICE READY light should then go out.

14   Inspect the directions in which sparks flew on the worksheet. Sparks fly uniformly in all directions when the nozzle unit is correctly centered.
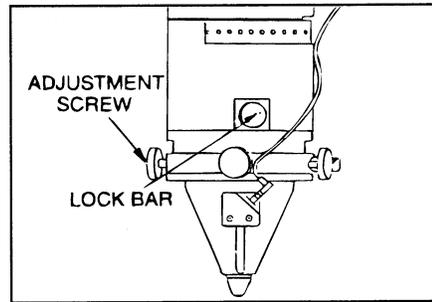
15   To correct the position of the nozzle unit, adjust the position by using the four adjustment screws on the unit (see the figure below).
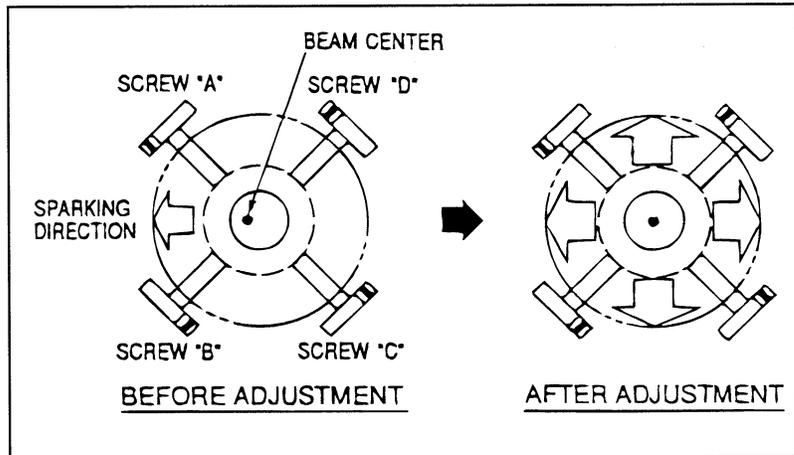
In this example, adjustment screws "A" and "B" are turned counterclockwise and "C" and "D" clockwise to align the nozzle unit center with the beam center.

16   Close the partition doors.

17   Clear the hazardous area of people and obstacles.

18   Press the SAFETY DEVICE RESET button, turning on the SAFETY DEVICE READY light.

19   Repeat Steps 6 to 18 until the nozzle unit is centered and sparks fly uniformly in all directions.

20   Turn the MODE keyswitch to ON, change the CNC mode to RETRACT, and then return the keyswitch to OFF.

21   Return all the machine axes to their origins.

22   Open the partition doors — the SAFETY DEVICE READY light should then go out.

23   Remove the worksheet.

Adjusting the lens focal point

Adjust the lens focal point as described below when the lens has been changed.

Without optional focal point CNC control

1   The procedure requires a mild steel sheet with a thickness of 1.6 mm. And the following program is needed — the dimensional data are in millimeters:

```
O7002(MANUAL FOCUS CHECK) ;
M102(SPC1.6) ;
M100 ;
E3 ;
#32=1. ;
IF[#4006NE20.] GOTO1 ;
#32=25.4 ;
N1 ;
G92 G90 X0. Y0. ;
M103 ;
G01 Y[-60./#32] ;
M104 ;
G00 X[8./#32] Y0. ;
M101 ;
M30 ;
```

2   Prepare the machine for a laser cutting operation in the normal manner — except to turn the lens dial fully clockwise after the lens is mounted on the laser head.
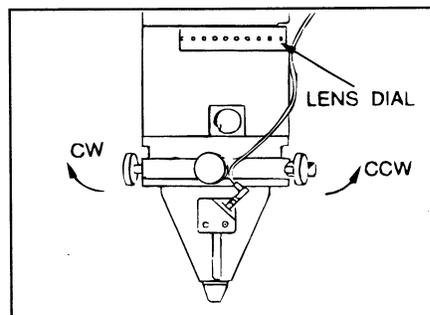
3   Set the worksheet on the machine table — see "Setting the worksheet" earlier in this section for the procedure.

4   Clear the hazardous area of people and obstacles.

5   Press the SAFETY DEVICE RESET button, turning on the SAFETY DEVICE READY light.

6   Turn the MODE keyswitch to ON and change the CNC mode to MANUAL.

7   Position the worksheet for cutting by shifting the X-axis and the Y-axis manually.

8　　Change the CNC mode to MEMORY and return the MODE keyswitch to OFF.

9　　Turn the SHUTTER keyswitch to ON.

10　　Press the START button to execute the program.

11　　When the machine is stopped by the M30 command, turn the SHUTTER keyswitch to OFF.

12　　Turn the MODE keyswitch to ON and change the CNC mode to MANUAL.

13　　Shift the Y-axis toward its origin manually so that adjustment can be made in Step 15 below.

14　　Open the partition doors — the SAFETY DEVICE READY light should then go out.

15　　Turn the lens dial four graduations (0.2 mm) counterclockwise to lower the lens focal point.

16　　Close the partition doors.

17　　Clear the hazardous area of people and obstacles.

18　　Press the SAFETY DEVICE RESET button, turning on the SAFETY DEVICE READY light.

19　　Repeat Steps 7 to 18 by changing the lens focal point.　Repeat the steps a few times by changing the lens focal point each time.

20　　Turn the MODE keyswitch to ON and change the CNC mode to MANUAL.

21　　Shift the Y-axis toward its origin manually so that adjustment can be made in Step 23 below.

22　　Open the partition doors — the SAFETY DEVICE READY light should then go out.

23　　Set the lens dial at the position where the narrowest cut width was obtained and then turn the dial 10 graduations (0.5 mm) counterclockwise.
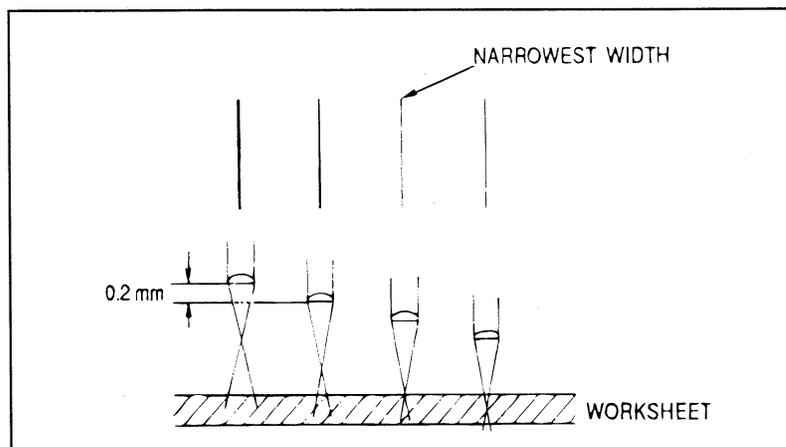
24   Close the partition doors.

25   Clear the hazardous area of people and obstacles.

26   Press the SAFETY DEVICE RESET button, turning on the SAFETY DEVICE READY light.

27   Change the CNC mode to RETRACT and return the MODE keyswitch to OFF.

28   Return all the machine axes to their origins.

29   Open the partition doors — the SAFETY DEVICE READY light should then go out.

30   Remove the worksheet.

With optional focal point CNC control

1   Call the focusing program O7001 shown below — the dimensional data are in millimeters:

```
O7001(NC FOCUS CHECK);
M102(SUS1.0);
M100;
E3;
#33=5. (START FOCAL POINT);
#31=15. (END FOCAL POINT);
#32=1.;
IF[#4006NE20.] GOTO1;
#32=25.4;
N1 WHILE[#33LE#31] DO1;
G90 G00 B[#33/#32];
G92 G90 X0. Y0. ;
M103;
G01 Y[-60./#32];
M104;
G00 X[8./#32] Y0.;
#33=#33+0.5;
END1;
M101;
M30;
```

Set the underlined portion according to the material name of the worksheet to be cut.

2   Set the worksheet on the machine table — see "Setting the worksheet" earlier in this section for the procedure.

3   Clear the hazardous area of people and obstacles.

4   Press the SAFETY DEVICE RESET button, turning on the SAFETY DEVICE READY light.

5   Show the CUTTING CONDITION display of the processing condition file selected in the program, and then enter 0.0 (mm) to item No.1 Focal on the display.

6   Set the "Focal point base pos." at 5 (mm) on the LASER PARAMETER display.   If the "Per-head focal point" setting function is set at ON, set the "Focal point" of the mounted lens at 5 (mm) on the AIV SETTING display.

7   Turn the MODE keyswitch to ON and change the CNC mode to MANUAL.

8   Position the worksheet for cutting by shifting the X-axis and the Y-axis manually.

> NOTE
>
> ● When the START button is pressed to execute the focusing program shown above, the laser head cuts a 60-mm slit while moving from the cutting start position in the −Y direction.   The laser head then moves 60 mm in the +Y direction to return to the position of Y=0, the table moves 8 mm in the +X direction, and they stop.
>
> When the START button is pressed again, the laser head repeats the same series of motions and the table moves another 8 mm in the +X direction.   Exercise due care when positioning the worksheet at the beginning of the adjusting procedure.

9   Change the CNC mode to MEMORY and return the MODE keyswitch to OFF.

10   Turn the SHUTTER keyswitch to ON.

11   Press the START button to execute the focusing program O7001.

12   After the completion of the program and the stop of the machine, increase the "Focal point base pos." by 0.5 (mm) on the LASER PARAMETER display.

If the "Per-head focal point" setting function is set at ON, after the completion of the program and the stop of the machine, increase the "Focal point" of the mounted lens by 0.5 (mm) on the AIV SETTING display.

13   Repeat Steps 11 and 12 by changing the focal point data.   Repeat the steps a few times by changing the focal point data each time.

14   Turn the MODE keyswitch to ON, change the CNC mode to RETRACT, and then return the keyswitch to OFF.

15   Return all the machine axes to their origins.

16   Open the partition doors — the SAFETY DEVICE READY light should then go out.

17 Remove the worksheet, study the results, and find the narrowest slit width.
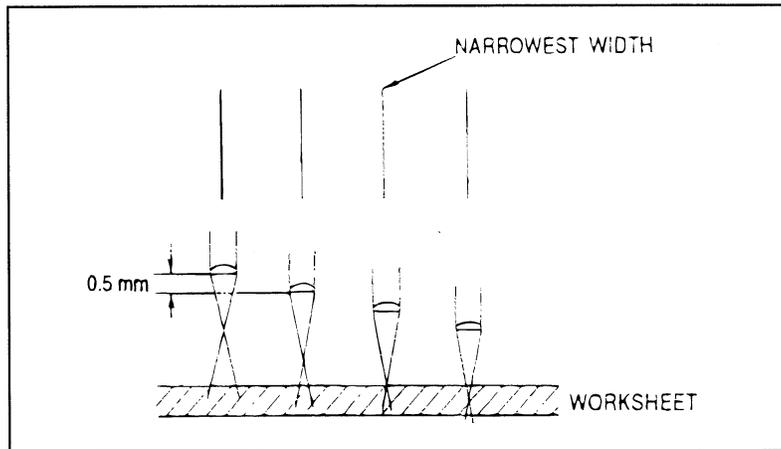
18 Return the "Focal point base pos." or "Focal point" setting on the above-mentioned display to the focal point data at which a slit is cut to the narrowest width.

LINE OPERATION PROCEDURE

Operate the line for laser cutting in the SCHEDULE or AUTO mode according to one program or a scheduled series of programs as described below when preparation has been completed for a line operation.

⚠ WARNING	● When working inside the hazardous area around the shuttle table and machine, press the STOP button on the line control panel or the LINE STOP button on the CNC control panel. Then turn the SHUTTER keyswitch to OFF, remove the key from the switch, and hold it by yourself — to prevent the line from being started by mistake.
	● Clear the hazardous area around the shuttle table and machine of people and obstacles before starting the line — to prevent injuries and accidents.

⚠ CAUTION	● The goggles are only designed to protect beams of a specific range of waves. Check then that the type of goggles is adapted to the length of wave specific to the CO_2 laser, that is 10.6 μm. This value is given on the signal plates fixed on the source and on the laser head (see layout plan).

SCHEDULE mode operation

An automatic cutting operation can be performed in the SCHEDULE mode according to a scheduled series of programs, which need to be registered in the CNC memory beforehand, as described below:

1   Prepare the machine, assist gas, lens, and nozzle unit to perform the operation as required by the programs to be used.   Refer to "Preparation procedure" earlier in this Part.

2   Prepare the shuttle table for operation by referring to the separate shuttle table manual.

3   Load a worksheet on each shuttle table pallet.   (Refer to the separate shuttle table manual for the procedure.)

4 Show the MAIN MENU display on the line control panel screen and press to light the SCH button on the screen.

5 Return all the machine axes to their origins — see "Manual operations" later in this Part for the procedure.

6 Set the required conditions by using the buttons in the lower middle section of the CNC control panel.

7 Change the override multiplication rate for each cutting condition as required.   (Refer to Part II, Displays, for the procedure.)

8 Schedule registered programs for their execution in sequence — see "Scheduling programs" later in this section for the procedure.

9 Press the Custom key, the right- or left-end arrowhead softkey, and the Schedule Data softkey, showing the SETTING (JOB SCHEDULE) display.

SETTING (JOB SCHEDULE)										O1234 N56789
JOB	PROGRAM	SHEET	SHELF 1	SHELF 2	RESER VED	JOB	PROGRAM	SHEET	SHELF 1	SHELF 2	RESER VED
01						14					
02						15					
03						16					
04						17					
05						18					
06						19					
07						20					
08						21					
09						22					
10						23					
11						24					
12						25					
13						26					
						JOB		DONE		REMAIN	

10 Turn the MODE keyswitch to ON, change the CNC mode to MEMORY, and then return the keyswitch to OFF.

11 Show the RUN MONITOR display on the line control panel screen and confirm that the READY prompt appears on the screen.

12 Turn the SHUTTER keyswitch to ON.

13 Clear the hazardous area of people and obstacles.

14 Press the SAFETY DEVICE RESET button, turning on the SAFETY DEVICE READY light.

15 The schedule is started by executing the program O9030.

Scheduling programs

Registered programs can be arranged in one schedule for their consecutive execution in a SCHEDULE mode operation. The scheduled programs will be given JOB Nos. 01 to 26 according to their scheduled sequence, which will be the order of their execution.

NOTE

● Only one schedule can be stored in the CNC memory at a time.

1 Press the Custom key, the right- or left-end arrowhead softkey, and the Schedule Data softkey, showing the SETTING (JOB SCHEDULE) display.

NOTE

● To clear all of the data scheduled before, press the ALL CLEAR softkey.

2 Move the cursor to JOB No.01.

3 Key-in a number for the program to be executed in the job and press the Input key.

4 Key-in a number of worksheets to be cut in the job and press the Input key.

5 Key-in shelf numbers for the loading pallets to be used for the job, on which worksheets need to be stacked beforehand, and press the Input key. (Specify the number for the second shelf and then the number for the first shelf.)

6 Key-in shelf numbers for the unloading pallets to be used for the job, on which parts are piled after cutting, and press the Input key. (Specify the number for the second shelf and then the number for the first shelf.)

7 Repeat the procedure for the remaining job numbers that require program and pallet numbers and quantity of worksheets.

NOTE

● To specify the end of the schedule, key-in "0 (zero)" instead of the program number or omit the program number.

SINGLE OPERATION PROCEDURE

Perform an automatic operation in the MEMORY or MDI mode by using one program as described below when preparation has been completed for the operation.

⚠ WARNING	● When working inside the hazardous area around the machine, press the STOP buttons on the CNC control panel and the shuttle table control panel. Then turn the SHUTTER keyswitch to OFF, remove the key from the switch, and hold it by yourself — to prevent the machine from being started by mistake.
	● Clear the hazardous area around the machine of people and obstacles before starting the machine — to prevent injuries and accidents.

⚠ CAUTION	● The goggles are only designed to protect beams of a specific range of waves. Check then that the type of goggles is adapted to the length of wave specific to the CO_2 laser, that is 10.6 μm. This value is given on the signal plates fixed on the source and on the laser head (see layout plan).

MEMORY mode operation

An automatic cutting operation can be performed in the MEMORY mode by using one program registered in the CNC memory as described below:

By using single-part program

1   Prepare the machine, assist gas, lens, and nozzle unit to perform the operation as required by the program to be used. And set the worksheet on the machine table. Refer to "Preparation procedure" earlier in this Part.

2   Set the required conditions by using the buttons in the lower middle section of the CNC control panel.

3   Change the override multiplication rate for each cutting condition as required. (Refer to Part II, Displays, for the procedure.)

4 Show the required program on the PROGRAM display.   (Refer to Part IV, Program Management, for the procedure.)

5 Move the cursor to the start of the displayed program under the address character "O" for the program number if it is not.   The move may be achieved by pressing the REWIND softkey or the Reset key.

NOTE

● If the cursor is not at the start of the program, the program will be executed from where the cursor is.

6 Turn the SHUTTER keyswitch to OFF to turn on the red laser beam as required.   The red laser beam is useful when positioning the worksheet in Step 7 below.

7 Position the worksheet according to the programmed worksheet origin (G90 G92 X__ Y__ ;) so that cutting will start correctly. (Shift the X-axis and the Y-axis manually to position the worksheet — see "Manual operations" later in this Part.)

8 Turn the MODE keyswitch to ON, change the CNC mode to MEMORY, and then return the keyswitch to OFF.

9 Turn the SHUTTER keyswitch to ON.

10 Clear the hazardous area of people and obstacles.

11 Press the SAFETY DEVICE RESET button, turning on the SAFETY DEVICE READY light.

12 Press the START button to start the operation — the button light will be turned on during the operation.

NOTICE

● To prevent the worksheet from hitting the laser head, be sure to zero-return the Z-axis before unloading the machine table upon completion of the operation.

By using multiple-part program

NOTE

● The worksheet origin command (G90 G92 X__ Y__ ;) in the program must be equal to the maximum travel range applied to the machine.
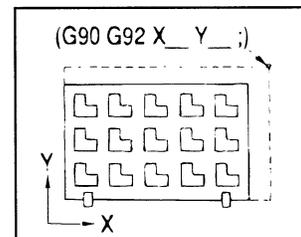
(G90 G92 X__ Y__ ;)

1 Prepare the machine, assist gas, lens, and nozzle unit to perform the operation as required by the program to be used.   And set the worksheet on the machine table.   Refer to "Preparation procedure" earlier in this Part.

2   Return all the machine axes to their origins — see "Manual operations" later in this Part for the procedure.

3   Set the required conditions by using the buttons in the lower middle section of the CNC control panel.

4   Change the override multiplication rate for each cutting condition as required.   (Refer to Part II, Displays, for the procedure.)

5   Show the required program on the PROGRAM display.   (Refer to Part IV, Program Management, for the procedure.)

6   Move the cursor to the start of the displayed program under the address character "O" for the program number if it is not.   The move may be achieved by pressing the REWIND softkey or the Reset key.

NOTE

● If the cursor is not at the start of the program, the program will be executed from where the cursor is.

7   Turn the MODE keyswitch to ON, change the CNC mode to MEMORY, and then return the keyswitch to OFF.

8   Turn the SHUTTER keyswitch to ON.

9   Clear the hazardous area of people and obstacles.

10 Press the SAFETY DEVICE RESET button, turning on the SAFETY DEVICE READY light.

11 Press the START button to start the operation — the button light will be turned on during the operation.

NOTICE

● To prevent the worksheet from hitting the laser head, be sure to zero-return the Z-axis before unloading the machine table upon completion of the operation.

MDI mode operation

A new program can be created on the CNC control panel screen and executed as described below:

1   Turn the MODE keyswitch to ON, change the CNC mode to MDI, and then return the keyswitch to OFF.

2   Press the Program key to show the PROGRAM (MDI) display. Then press the MDI softkey if necessary.

3   Key-in data for the first block of the program by using address and numeric keys.   Then press the EOB key to enter the end-of-block code (;).

4   Then press the Insert key.

> ### NOTE
>
> ● After having pressed the Insert key, any correction can be made in the same manner as described in Part IV, Program Management — except that it is not necessary to change the CNC mode.

5   Enter data for the successive blocks in the same manner.

6   Upon completion of the data entry, press the REWIND softkey to move the cursor to the start of the created program.

7   Clear the hazardous area of people and obstacles.

8   Press the SAFETY DEVICE RESET button, turning on the SAFETY DEVICE READY light.

9   Press the START button to start the operation.   When the operation is completed, the created program will be cleared from the screen.

STOPPING PROCEDURE

Normal shutdown

Normally shut down the machine as described below.

⚠ WARNING	● When working inside the hazardous area around the machine, press the STOP buttons on the CNC control panel and the shuttle table control panel. Then turn the SHUTTER keyswitch to OFF, remove the key from the switch, and hold it by yourself — to prevent the machine from being started by mistake.

⚠ CAUTION	● Do not touch the lens surfaces when handling the lens.

1   Turn the SHUTTER keyswitch to OFF.

2   Turn the LASER keyswitch to OFF — the HIGH VOLTAGE and LASER READY lights should then go out.

3   After the above described lights are turned off, shut off the main and stop valves of the laser gas cylinder.

4   Shut off the main valve of the assist gas cylinder used.

5   Return all the machine axes to their origins — see "Manual operations" later in this Part for the procedure.   Then shift the Y-axis to the end opposite to the origin, and lower the Z-axis to a position about 150 mm above the machine table in the MANUAL mode.

6   Open the partition doors — the SAFETY DEVICE READY light should then go out.

7   Dismount the lens from the laser head in the following manner:

(1) Disconnect the Z-axis tracking sensor cable from nozzle unit board.

(2) Pull out the nozzle unit lock bar on the laser head and detach the unit by turning it counterclockwise (viewed from the bottom).

(3) Remove the lens by turning it counterclockwise and then store it in its case.

(4) Replace the nozzle unit by turning it clockwise and then push in the lock bar.

(5) Connect the Z-axis tracking sensor cable to the nozzle unit.

(6) Close the partition doors.

8   Press the POWER OFF (**O**) button on the CNC control panel.

9   Turn off the circuit breaker switch on the electrical control unit and lock it.

10   Turn off the circuit breaker switch on the laser oscillator and lock it.

11   Turn off the circuit breaker switch on the transformer box.

12   Shut off the intake valve of the air system and lock it, and stop the supply of compressed air to the machine.

13   Turn off the shop circuit breaker switch.

NOTICE

● Keep the cooling unit turned on.

Shutdown by auto-power-off function

Shut down the machine by using the auto-power-off function as described below.

Prepare the machine for automatic operation as normally done, press the AUTO POWER OFF button to turn on the built-in light, and execute the program. When the program is completed or the automatic operation of the machine is stopped by an alarm, the auto-power-off function activates. After a few minutes, the power of the laser oscillator and CNC automatically turns off, and the circuit breaker switches on the electrical control unit and laser oscillator assume the "TRIP" condition.

End the day's work as described below.

1 Turn the SHUTTER keyswitch to OFF.

2 Turn the LASER keyswitch to OFF — the HIGH VOLTAGE and LASER READY lights should then go out.

3 Shut off the main and stop valves of the laser gas cylinder.

4 Shut off the main valve of the assist gas cylinder used.

5 Open the partition doors — the SAFETY DEVICE READY light should then go out.

6 Dismount the lens from the laser head in the following manner:

   (1) Disconnect the Z-axis tracking sensor cable from nozzle unit board.

   (2) Pull out the nozzle unit lock bar on the laser head and detach the unit by turning it counterclockwise (viewed from the bottom).

   (3) Remove the lens by turning it counterclockwise and then store it in its case.

   (4) Replace the nozzle unit by turning it clockwise and then push in the lock bar.

   (5) Connect the Z-axis tracking sensor cable to the nozzle unit.

   (6) Close the partition doors.

7 Turn off the circuit breaker switch on the electrical control unit and lock it.

8 Turn off the circuit breaker switch on the laser oscillator and lock it.

9 Turn off the circuit breaker switch on the transformer box.

10 Shut off the intake valve of the air system and lock it, and stop the supply of compressed air to the machine.

11 Turn off the shop circuit breaker switch.

NOTICE

● Keep the cooling unit turned on.

INTERRUPTION & RESTARTING

The ongoing automatic operation will be or can be stopped by one of the following causes.   The stopped operation may be resumed from where it was stopped or must be carried out again from the beginning depending on the cause of the stop or the situation.

⚠ WARNING	● When working inside the hazardous area around the machine, press the STOP buttons on the CNC control panel and the shuttle table control panel. Then turn the SHUTTER keyswitch to OFF, remove the key from the switch, and hold it by yourself — to prevent the machine from being started by mistake.

EMERGENCY STOP buttons

The EMERGENCY STOP buttons stop the ongoing operation, the laser oscillator's high-voltage discharge, and the laser gas supply.   The stopped operation is terminated and cannot be resumed.

To restart the operation again from the beginning, remove the cause for the stop, unlock the pressed EMERGENCY STOP button by inserting the key and turning it clockwise; then press the Reset key to reset the CNC, and manually zero-return all the machine axes.   The stopped high-voltage discharge must also be restarted.   See "Manual operations" later in this Part and Part V, Alarms, for more information.

LINE STOP button

The LINE STOP button stops and terminates the ongoing schedule operation.   The stopped operation cannot be resumed.

To restart the operation again from the beginning, remove the cause for the stop.

STOP button on CNC control panel

The STOP button on the CNC control panel interrupts the ongoing laser-cutting operation.   Although the stopped operation can be resumed, an interrupted cutting process may not correctly be resumed.

Press the START button to resume the operation.   To cancel the operation, press the Reset key to reset the CNC.

STOP button on shuttle table control panel

The STOP button on the shuttle table control panel interrupts the ongoing pallet-handling.

Press the RESTART button on the same control panel and then the START button to resume the operation.

Reset key

The Reset key stops and terminates the ongoing laser-cutting operation. The stopped operation cannot be resumed.

To restart the operation again from the beginning, remove the cause for the stop and zero-return all the machine axes — see "Manual operations" later in this Part.

Alarms

The laser cutting operation stops and the ALARM light comes on when an alarm condition has been caused — the cause can be identified by showing the ALARM MESSAGE display or the OPERATOR MESSAGE display. The cause of the alarm condition determines whether the operation can be resumed or must be carried out again from the beginning after removing the cause of the stop — see Part V, Alarms, for the description of alarm conditions and remedies.

Single block function

The laser cutting operation is stopped every time one block of the program has been executed when this function is effective with the SINGLE BLOCK button light on. The function will be ignored, however, when the laser oscillator shutter is open.

Press the START button to continue the operation to execute the next block.

Program stop command

The program stop command (M00) in the program stops the ongoing laser-cutting operation every time the command is executed — the PROGRAM STOP light then comes on.

Press the START button to resume the operation to continue the execution of the program.

NOTE

● The program terminates and the operation will stop when the G50, M02, or M30 command is executed.

Optional stop command

The optional stop command (M01) in the program stops the ongoing laser-cutting operation every time the command is executed when this function is effective with the OPT STOP button light on — the PROGRAM STOP light then comes on.

Press the START button to resume the operation to continue the execution of the program.

MANUAL OPERATIONS

Procedures for the manual jog feed and zero-return of the X-, Y-, and Z-axes are described in this section.

⚠ WARNING	● Clear the hazardous area around the machine of people and obstacles before starting the machine — to prevent injuries and accidents.

NOTE

● Unless an shuttle table pallet is deposited on the machine table, the X-axis cannot be moved or zero-returned.   Take the following steps:

(1) Show the SYSTEM RUNNING display.

(2) Show the SYSTEM MDI display.

(3) Press the RETURN softkey and then the EXEC softkey, locking the pallet-setter and raising its pins.

Manual axis jog

1   Clear the hazardous area of people and obstacles.

2   Press the SAFETY DEVICE RESET button, turning on the SAFETY DEVICE READY light.

3   Turn the MODE keyswitch to ON, change the CNC mode to MANUAL, and then return the keyswitch to OFF.

4   Press the required FEED button.   The axis will travel at jog speed as long as the button is kept pressed.

Manual zero-return

1   Clear the hazardous area of people and obstacles.

2   Press the SAFETY DEVICE RESET, button, turning on the SAFETY DEVICE READY light.

3   Turn the MODE keyswitch to ON, change the CNC mode to RETRACT, and return the MODE keyswitch to OFF.

4   Press the +Z FEED button.   The light of the button blinks to indicate that the Z-axis is zero-returning and stays on to indicate that the Z-axis has completed the zero-return.

NOTE

● When the Z-axis is initially located near the origin, it once moves away from the origin before returning to the origin.

5   Press the +X and +Y FEED buttons together.   The lights of the buttons blink to indicate that the X- and Y-axes are zero-returning and stay on to indicate that the X- and Y-axes have completed the zero-return.

NOTE

● When the X- and Y-axes are initially located near the origin, they once move away from the origin before returning to the origin.

Part IV

Program Management

PROGRAM MANAGEMENT

Making preparations

Make the preparations for managing a program as described below.

1. Turn the EDIT PROTECT keyswitch to OFF.

2. When the machine has the optional subcarriage, select a series of displays for either the main carriage or subcarriage. Press the Shift and Help keys together to change to either series of displays. "SUB" is shown to indicate that a subcarriage display is active.

3. Change the CNC mode to EDIT.

4. Press the Program key.

5. If the PROGRAM display is not shown, press the PRGRM softkey to show the PROGRAM display.

Showing program directories

Showing directory of programs registered in CNC memory

Show the directory of programs registered in the CNC memory as described below.

1. Press the DIR softkey to show the PROGRAM DIRECTORY display. The PROGRAM DIRECTORY display will show full-screen the directory of programs registered.

2. If the program directory covers more than one page, press either of the Page keys to scroll between the pages.

Showing directory of programs stored in floppy disk

Show the directory (file numbers) of programs stored in the floppy disk as described below.

1. Open the floppy disk drive cover, insert the floppy disk in the direction shown at right, and close the cover.

2. Press the FLOPPY softkey.

3. Press the OPRT softkey.

4. Press the F SRH softkey.

5. Key-in "1 (file number)" and press the F SET softkey. Any other desired file number may also be specified.
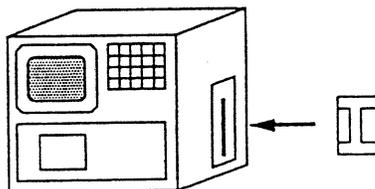
6   Press the EXEC softkey to show the specified file number and the subsequent file numbers.

7   Press the CAN softkey to go to the next operation.

Searching for program

Show the contents of a program registered in the CNC memory as described below.

Searching for program by its number

1   Following the address "O," key-in the number of the program to be searched for.

2   Press the O SRH softkey (or the Cursor ↓ or → key).

3   When the search is completed, the number and name of the program located by the search will appear at the top of the screen.

Scanning

Press the O SRH softkey.   Each time the softkey is pressed, one of the programs registered in the CNC memory is shown on the screen. When all of the programs are shown, the screen returns to the display of the first program.   The programs are shown in the order they have been registered in the CNC memory, not in their numerical order.

Registering programs in CNC memory

NOTE

● Program Nos. O8000 to O9999 are used by AMADA for user macro programs and protected, so that they cannot be used for registering other programs.

Creating program on CNC control panel

Create a program on the CNC control panel and register it in the CNC memory as described below.

1 Following the address "O," key-in the number of the program to be registered in the CNC memory.

2 Press the Insert key to read the program number into the CNC memory.

3 Key-in each word of program data with the address and numeric keys. The keyed-in program data will be first stored in the key entry buffer.

4 Press the Insert key to read the program data from the key entry buffer into the CNC memory.

5 Repeat steps 3 and 4 to read other program data into the CNC memory.

Reading program from floppy disk into CNC memory

Read a program from the floppy disk and register it in the CNC memory as described below.

1 Open the floppy disk drive cover, insert the floppy disk in the direction shown at right, and close the cover.
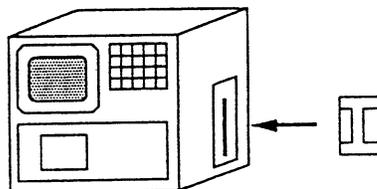
2 Show the directory of programs registered in the CNC memory to confirm an unused program number.

3 Show the directory of programs stored in the floppy disk to confirm the file number of the program to be read into the CNC memory.

4 Press the CAN softkey.

5 Press the READ softkey. "READ FILE NO. =" and "PROGRAM NO. =" will appear at the lower left of the screen.

6 Key-in the file number of the program to be read from the floppy disk and press the F SET softkey.

7 Key-in the number of the program to be registered in the CNC memory and press the O SET softkey.

8 Press the EXEC softkey to start reading the program.

Storing program in floppy disk

Write a program from the CNC memory and store it in the floppy disk as described below.

1 Open the floppy disk drive cover, insert the floppy disk in the direction shown at right, and close the cover.
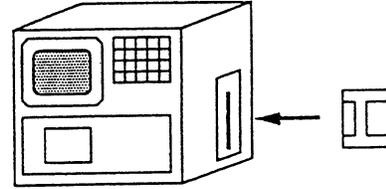
2 Show the directory of programs registered in the CNC memory to confirm the number of the program to be written onto the floppy disk.

3 Show the directory of programs stored in the floppy disk to confirm the file number of the program to be used.

4 Press the CAN softkey.

5 Press the PUNCH softkey. "PUNCH FILE NO. =" and "PROGRAM NO. =" will appear at the lower left of the screen.

6 Key-in the file number of the program to be stored in the floppy disk and press the F SET softkey. If this step is omitted, the CNC will automatically set an arbitrary file number.

7 Key-in the number of the program to be written from the CNC memory and press the O SET softkey.

8 Press the EXEC softkey to start writing the program.

Deleting program or all programs

Deleting program

Delete a program registered in the CNC memory as described below.

1   Following the address "O," key-in the number of the program to be deleted.

2   Press the Delete key to delete the program.   The program registered after the deleted program will be shown.

Deleting all programs

Delete all the programs registered in the CNC memory as described below.

1   Following the address "O," key-in "–9999."

2   Press the Delete key to delete all the programs registered in the CNC memory.

PROGRAM EDIT

Making preparations

Make the preparations for editing a program as described below.

1 Turn the EDIT PROTECT keyswitch to OFF.

2 When the machine has the subcarriage, select a series of displays for either the main carriage or subcarriage. Press the Shift and Help keys together to change to either series of displays. "SUB" is shown to indicate that a subcarriage display is active.

3 Change the CNC mode to EDIT.

4 Press the Program key.

5 If the PROGRAM display is not shown, press the PRGRM softkey to show the PROGRAM display.

6 Press the OPRT softkey to change to the editing softkey menu. (The editing softkey menu can also be shown by pressing any of the address and numeric keys.)

NOTE

● Programs O8000 to O9999 are used by AMADA as user macro programs and protected, so that they cannot be edited.

● Before running the program upon completion of the edit, make sure that the CNC is reset and that the cursor is positioned at the beginning of the program.

Scrolling between pages and moving cursor

Scrolling between pages

Press the Page down key to change the display to the next page and to move the cursor to the word at the beginning of the page.

Press the Page up key to change the display to the previous page and to move the cursor to the word at the beginning of the page.

Hold down either Page key to continuously scroll between the pages.

Moving cursor

Press the Cursor → key to move the cursor to the next word.

Press the Cursor ← key to move the cursor to the previous word.

Press the Cursor ↓ key to move the cursor to the next line.

Press the Cursor ↑ key to move the cursor to the previous line.

Hold down any Cursor key to continuously move the cursor.

Returning cursor to beginning of program

Return the cursor to the beginning of the displayed program as described below.

Press the REWIND softkey in the EDIT mode or the Reset key in the MEMORY or EDIT mode. The Reset key cannot be used to return the cursor to the beginning of the displayed program during background program editing. When the Reset key is pressed, the ongoing automatic operation is stopped and canceled.

Searching for word

Searching in downward direction

Use the SRH ↓ softkey to search for the specified word in the downward direction from the current cursor position as follows:

<u>G90</u> G92 X0 Y0;

    :

E001;

    :

E002;

    :

M30;

In the above program, key-in "E (address of the word)" and press the SRH ↓ softkey (or the Cursor ↓ or → key) to move the cursor to "E001."

G90 G92 X0 Y0;

    :

<u>E001</u>;

    :

E002;

    :

M30;

To search for "M30" in the same program, key-in "M30 (whole word) " and press the SRH ↓ softkey (or the Cursor ↓ or → key).

G90 G92 X0 Y0;

    :

E001;

    :

E002;

    :

<u>M30</u>;

NOTE

● "M30" cannot be searched for by keying-in "M3" alone.

Searching in upward direction

Use the SRH ↑ softkey to search for the specified word in the upward direction from the current cursor position as follows:

G90 G92 X0 Y0;

:

<u>M30</u>;

To search for "G90" in the above program, key-in "G90" and press the SRH ↑ softkey (or the Cursor ↑ or ← key).

<u>G90</u> G92 X0 Y0;

:

M30;

Altering word

Alter a word as described below.

Example: Alter I20 to I18 in

                           G111 X150 Y80 <u>I20</u> J10;

After alteration: G111 X150 Y80 <u>I18</u> J10;

1   Move the cursor to the word to be altered ("I20" in this example).

2   Key-in the new word to replace the existing word ("I18" in this example).

3   Press the Alter key (to alter "I20" to "I18" in this example).

Inserting word or words

Insert a new word or words between existing words as described below.

Example: Insert R3 after J10 in

                           G111 X150 Y80 I18 <u>J10</u>;

After insertion: G111 X150 Y80 I18 J10 <u>R3</u>;

1   Move the cursor to the word after which a new word or words are to be inserted ("J10" in this example).

2   Key-in the new word or words ("R3" in this example).

3   Press the Insert key (to insert "R3" after "J10" in this example).

Deleting word or words

Deleting word

Delete a word as described below.

Example: Delete R3 in

G111 X150 Y80 I18 J10 <u>R3</u>;

After deletion: G111 X150 Y80 I18 J10<u>;</u>

1   Move the cursor to the word to be deleted ("R3" in this example).

2   Press the Delete key (to delete "R3" in this example).

Deleting words from word in block to end-of-block code of block

Delete words from a word in a block to the EOB code of the block as described below.

Example: Delete words from J10 to first EOB code in

G111 X150 Y80 I18 <u>J10</u> Q5 R3;
G00 X100 Y-5;
E003;

After deletion: G111 X150 Y80 I18 G00 X100 Y-5;
<u>E003</u>;

1   Move the cursor to the first of the words to be deleted together ("J10" in this example).

2   Press the EOB key and the Delete key (to delete the words from "J10" to ";" in this example). The cursor will move to the word after the last word deleted.

Deleting blocks

Delete words, from the word at which the cursor is currently positioned to the block where the specified sequence number is present, as described below.

Example: Delete blocks [I] to [II] in

G112 X25 Y25;
<u>G00</u> X0 Y-5;   --- [I]
E003;
M103;
.
.
.
N20 M104;   --- [II]
G00 G40 X100 Y0;

After deletion: G112 X25 Y25;
<u>G00</u> G40 X100 Y0;

1   Move the cursor to the word at the beginning of the first block to be deleted ("G00" in block [I] in this example).

2   Key-in the sequence number and press the Delete key (key-in "N20" and press the Delete key to delete blocks [I] to [II] in this example).   The cursor will move to the block after the last block deleted.

Deleting words from word where cursor is currently positioned to specified word

Delete words from the word at which the cursor is currently positioned to the specified word as described below.

Example: Delete words from G00 in block [I] to X25 in block [II] in

G00 G41 X25 Y-5;
E003;
M103;
G01 Y0;
<u>G00</u>;   --- [I]
G01 X0;
G00;
G01 Y50;
G00;
G01 X25;   --- [II]
G00;
G01 X50 Y25;

After deletion: G00 G41 X25 Y-5;
E003;
M103;
G01 Y0;
:
↓
G00;
G01 X50 Y25;

1   Move the cursor to the first word to be deleted ("G00" in block [I] in this example).

2   Key-in the last word to be deleted and press the Delete key (key-in "X25" and press the Delete key to delete the words other than the last EOB code between blocks [I] and [II] in this example).   The cursor will move to the word after the last word deleted.

NOTE

● The words are deleted to the first occurrence of the specified word.

Copying program

Assign a new program number to part or all of the currently shown program and register part or all of the program under the new program number in the CNC memory as described below.   The original program is left unchanged after copying.

NOTE

● When the EXEC softkey is pressed without specifying the new program number, the selected program part is registered under program No. O0000. If a program is already registered under No. O0000, the selected program part overwrites the program.

● If a program number already registered is specified, an alarm occurs.

Copying all of program

1   Press the EX-EDT softkey.

2   Press the COPY softkey.

3   Press the ALL softkey.

4   Key-in a new program number and press the Input key.

5   Press the EXEC softkey.

Copying part of program

1   Press the EX-EDT softkey.

2   Press the COPY softkey.

3   Move the cursor to the first word of the program part to be copied and press the CRSL–softkey.

4   To copy the program part from the current cursor position to the end of the program, leave the cursor at the current position and press the –BTTM softkey.   To copy the program part from the current cursor position to a word before the end of the program, move the cursor to the last word of the program part to be copied and press the –CRSL softkey.

5   Key-in a new program number and press the Input key.

6   Press the EXEC softkey.

Moving program

Assign a new program number to part or all of the currently shown program and register part or all of the program under the new program number in the CNC memory as described below. Part or all of the original program is not left after moving.

NOTE

● When the EXEC softkey is pressed without specifying the new program number, the selected program part is registered under program No. O0000. If a program is already registered under No. O0000, the selected program part overwrites the program.

● If a program number already registered is specified, an alarm occurs.

Moving all of program

1 Press the EX-EDT softkey.

2 Press the MOVE softkey.

3 Press the ALL softkey.

4 Key-in a new program number and press the Input key.

5 Press the EXEC softkey.

Moving part of program

1 Press the EX-EDT softkey.

2 Press the MOVE softkey.

3 Move the cursor to the first word of the program part to be moved and press the CRSL– softkey.

4 To move the program part from the current cursor position to the end of the program, leave the cursor at the current position and press the –BTTM softkey. To move the program part from the current cursor position to a word before the end of the program, move the cursor to the last word of the program part to be moved and press the –CRSL softkey.

5 Key-in a new program number and press the Input key.

6 Press the EXEC softkey.

Inserting program

Insert a registered program in the currently shown program as described below. The original program is left unchanged after inserting.

NOTE

● When the EXEC softkey is pressed without specifying the program number, the program registered under No. O0000 is inserted in the current program. If the program number O0000 is not registered, an alarm occurs.

● If an unregistered program number is specified, an alarm occurs.

Inserting after specified word in current program

1   Press the EX-EDT softkey.

2   Press the MERGE softkey.

3   Move the cursor to the word after which another program is to be inserted and press the –'CRSL softkey.

4   Key-in the program number for the program to be inserted in the current program and press the Input key.

5   Press the EXEC softkey.

Inserting after end of current program

1   Press the EX-EDT softkey.

2   Press the MERGE softkey.

3   Press the –BTTM' softkey.

4   Key-in the program number for the program to be inserted in the current program and press the Input key.

5   Press the EXEC softkey.

Replacing address or word

Replace the specified address or word in the currently shown program with another address or word as described below.

NOTE

● The replacement procedure starts with the word immediately after the cursor.
● A word can be composed of up to 40 characters.

Replacing all occurrences of specified address or word after cursor

1   Press the EX-EDT softkey.

2   Press the CHANGE softkey.

3   Key-in the address or word to be replaced.

4   Press the BEFORE softkey.

5   Key-in a new address or word.

6   Press the AFTER softkey to move the cursor to the first occurrence of the specified address or word.

7   Press the EXEC softkey to replace all occurrences of the specified address or word after the cursor with the new address or word.

Replacing each occurrence of specified address or word after cursor with confirmation

1   Press the EX-EDT softkey.

2   Press the CHANGE softkey.

3   Key-in the address or word to be replaced.

4   Press the BEFORE softkey.

5   Key-in a new address or word.

6   Press the AFTER softkey to move the cursor to the first occurrence of the specified address or word.

7   Press the EX-SGL softkey to replace the first occurrence of the specified address or word after the cursor with the new address or word and to move the cursor to the next occurrence of the specified address or word.
Press the SKIP softkey to continue without replacing each occurrence.

8   Repeat step 7 to replace each occurrence of the specified address or word with confirmation.

BACKGROUND EDIT

Programs can be registered, written, deleted, or edited, irrespective of the CNC mode and CNC status (whether or not the machine is automatically operated). Edit performed when the CNC mode is EDIT is called foreground edit. Edit performed when the CNC mode is other than EDIT is called background edit. (The background edit can be performed even if the foreground is in the EDIT mode.) Any CNC alarm caused in the background has no effect on automatic operation in the foreground. The background edit is not affected by any CNC alarm caused during automatic operation in the foreground.

NOTE

● A program called in the background cannot be automatically run nor used as a subprogram in automatic operation.

● A program currently called in the foreground cannot be edited in the background. (Alarm number 140)

● The message "BP/S ALARM" appears in the lower left section of the screen when a CNC alarm is caused during background editing.

● All programs cannot be deleted in the background.

● A CNC alarm caused in the background can be cleared by pressing the EOB key. When the Reset key is pressed, the ongoing automatic operation in the foreground is stopped and canceled.

Starting background edit

On the PROGRAM display, press the BG-EDIT softkey to enable the background edit function and change the display to the PROGRAM (BG-EDIT) display. Programs can be registered, written, deleted, or edited in the same way as in the foreground.

Ending background edit

Press the BG-END softkey to end the background edit function.

Part V

Alarms

⚠ WARNING	● When working inside the hazardous area around the shuttle table and machine, take the following steps to prevent the line or machine from being started by mistake: 1) Press the STOP button on the line control panel or the STOP button on the CNC. 2) Turn the SHUTTER keyswitch to OFF, remove the key from the switch, and hold it by yourself. ● Turn off the power before opening the electrical control unit or the laser oscillator — they have a deadly high voltage inside.

CNC ALARMS

The ALARM light comes on when an alarm is caused with the CNC. The alarm can be identified by showing the ALARM MESSAGE display — press the Message key and then press the ALARM softkey. To proceed, remove the cause of the alarm, reset the CNC, correct the program if necessary, return all the machine axes to their origins, and then restart operation from the beginning. If the alarm cannot be reset, contact AMADA.

NOTE

● CNC alarms caused in connection with background program editing can be identified by a number — shown on the side of the message "BP/S ALARM" blinking in the lower left section of the PROGRAM (BG-EDIT) display.

NOTICE

● Use the EOB key to clear a CNC alarm caused during the background program editing session. Using the Reset key will terminate the ongoing automatic operation.

If any alarm that is not described in this section has been caused, contact AMADA.

PROGRAM ALARMS

000	CNC must be turned off. (Turn off CNC and then turn it on again.)
001	TH alarm. Program has character of wrong parity. (Correct program.)
002	TV alarm — caused only when TV check is effective. Program has block with incorrect number of characters. (Correct program.)
003	Data with excessive number of digits has been found. (Correct program.)
004	Block without address and beginning with numeral, minus sign or decimal point has been found. (Correct program.)
005	Block without data following address and followed by next block's address or end-of-block code has been found. (Correct program.)
006	Word with misplaced minus sign or two minus signs has been found. (Correct program.)
007	Word with misplaced decimal point or two decimal points has been found. (Correct program.)

009   Illegal characters have been found in significant block of data. (Correct program.)

010   Invalid G-code command has been found.   (Correct program.)

011   Cutting feed rate is not specified or invalid.   (Correct program.)

015   Number of simultaneously controlled axes exceeds limit. (Correct program.)

021   Incorrect coordinate data has been found in G17, G18 or G19 block during arc cutting.   (Correct program.)

030   D-data specifying laser beam path compensation is too large. (Correct program.)

033   Intersection point cannot be calculated for laser beam path compensation.   (Correct program.)

034   Startup or cancellation has been attempted during execution of G02 or G03 for laser beam path compensation.   (Correct program.)

037   Coordinate system for G17, G18 or G19 block has been changed during laser beam path compensation.   (Correct program.)

038   Radius at arc start or end is zero for laser beam path compensation and likely to cause overcutting.   (Correct program.)

041   Laser beam path compensation may result in overcutting. (Correct program.)

046   G80 block has incorrect P-data, which must be 2, 3 or 4. (Correct program.)

059   Specified program number is not found.

060   Specified sequence number is not found.

070   Memory is not sufficient.   (Delete unwanted programs to increase available memory.)

071   Specified address or program number is not found.

072   Memory is full with 400 programs registered.   (Delete unwanted programs to free memory.)

073   Program number entered for registration is already used. (Change number and reenter.)

074   Program number other than 1 to 9999 is specified.   (Change number and reenter.)

076   M98, G65, or G66 block has no P-data.   (Correct program.)

077   Five levels of nested subprograms are being called.   (Correct program.)

078   P-data for M98, M99, G65, or G66 block is not found in memory.   Or sequence number to which GOTOn was commanded cannot be found.   (Correct program.)

079   Program registered in CNC memory does not agree in contents with program read from input device.

085   Input device is not correctly selected and data cannot be read. (Check and correct setting.)

086   Data transmission is irregular or external device is not properly functioning and data cannot be read or output.   (Check and correct function of external device.)

087   More than ten characters were read following stop code. (Correct program.)

090   Signals are not received from pulse-coder and machine axes cannot be zero-returned.   (Contact AMADA.)

099   Axis travel has been commanded in MDI mode operation after searching for program.   (Correct program.)

100   Parameter Write "1" has been selected on SETTING display. (Change to Parameter Write "0".)

101   Power was turned off inadvertently during editing.   (Contact AMADA.)

110   Fixed-point absolute data is out of range.   (Correct program.)

111   Floating-point exponent data is out of range.   (Correct program.)

112   Zero or tan90° is entered as divisor.   (Correct program.)

113   Unavailable function has been commanded in macroprogram. (Correct program.)

114   Error was found in format other than expression format. (Correct program.)

115   Undefined variable is specified.   (Correct program.)

116	Illegal variable is assigned in left statement. (Correct program.)
118	Parenthetic multiplicity exceeds algebraic nesting limit of five levels. (Correct program.)
119	Negative argument is entered for SQRT or BCD. Or argument for BIN contains data other than 0 to 9. (Correct program.)
122	Nested macroprograms are being called exceeding two levels. (Correct program.)
123	Macro control command is used for operation in DNC mode. (Correct program.)
124	DO and END are specified incorrectly, which must have relationship of 1:1. (Correct program.)
125	Error was found in format of expressions. (Correct program.)
126	"n" is specified incorrectly in DOn, which must be $1 \leq n \leq 3$. (Correct program.)
127	CNC command and macro command are in one block. (Correct program.)
128	"n" is specified incorrectly in GOTOn, which must be $0 \leq n \leq 9999$. Or sequence number to which GOTOn was commanded cannot be found. (Correct program.)
129	Invalid address is used in argument. (Correct program.)
130	Both CNC and PMC have controlled same machine axis. (Contact AMADA.)
131	Five or more alarms are caused in external device. (Contact AMADA.)
132	Alarm without assigned number is caused in external device. (Contact AMADA.)
133	Error is found in small segment data in external device. (Contact AMADA.)
136	B-axis travel and another machine axis travel have been commanded simultaneously. (Correct program.)
140	Background program editing has been attempted on program currently in use in foreground. (Press EOB key.)

141	G34 has been commanded during laser beam path compensation. (Correct program.)
142	G34 block has incorrect P-data, which must be 1 to 999999. (Correct program.)
143	G34 block has out-of-range data setting. (Correct program.)
144	Coordinate system for G34 block does not agree with that for arc cutting or laser beam path compensation. (Correct program.)
148	Setting for automatic corner override function is out of range. (Contact AMADA.)
175	G107 has incorrect data. (Correct program.)
176	Invalid G-code command has been found in G107 block. (Correct program.)
178	G05 has been commanded during laser beam path compensation. (Correct program.)
180	Remote buffer PCB has problem. (Contact AMADA.)
210	M198 or M199 command is used for operation in schedule mode. Or M198 command is used for operation in DNC mode. (Correct program.)
222	Operation has been attempted by using external device during background program editing.
223	All machine axes must be zero-returned.
224	Automatic operation was started despite that all machine axes had not been zero-returned.
3011	In G111 block, necessary shape is not defined (by I, J, K, etc.), or another shape is defined. (Correct program.)
3012	In G112 block, necessary shape is not defined (by I, J, K, etc.), or another shape is defined. (Correct program.)
3013	In G113 block, necessary shape is not defined (by I, J, K, etc.), or another shape is defined. (Correct program.)
3014	In G114 block, necessary shape is not defined (by I, J, K, etc.), or another shape is defined. (Correct program.)
3015	In G115 block, necessary shape is not defined (by I, J, K, etc.), or another shape is defined. (Correct program.)

3016   In G116 block, necessary shape is not defined (by I, J, K, etc.), or another shape is defined.   (Correct program.)

3052   Nozzle gap, piercing condition, is zero.   (Correct processing condition file or program.)

3195   G115 or G116 block has no J-data.   (Correct program.)

3196   G115 or G116 block has R-data that is zero or less.   (Correct program.)

3197   G115 or G116 block has I-data that is 360 or more.   (Correct program.)

3198   G114 block has J-data that is less than 3.   (Correct program.)

3199   G114 block has R-data that is too large.   (Correct program.)

3200   G111 or G114 block has both R- and C-data.   (Correct program.)

3201   G114 block has C-data that is too large.   (Correct program.)

5010   End-of-record code has been commanded.   (Correct program.)

5016   Block has two or more M-codes of same group.   Or M-code to be independently programmed has been commanded with other codes.   (Correct program.)

APC (ABSOLUTE PULSE-CODER) ALARMS

Contact AMADA if any of these alarms has been caused.

300   n-axis must be zero-returned manually.

301   Communication error has been caused with n-axis APC.

302   Overtime error has been caused with n-axis APC.

303   Framing error has been caused with n-axis APC.

304   Parity error has been caused with n-axis APC.

305   Missed-pulse error has been caused with n-axis APC.

306   Voltage of n-axis APC cell has been reduced briefly to level
       that cannot hold data.

307   n-axis APC cell has almost been consumed and must be
       changed.

308   Voltage of n-axis APC cell has been reduced briefly (including
       times when power was turned off) to level that it must be
       changed.

SPC (SERIAL PULSE-CODER) ALARMS

Contact AMADA if any of these alarms has been caused.

350   n-axis SPC has irregularity.

351   Communication error has been caused with n-axis SPC.

SERVOSYSTEM ALARMS

Contact AMADA if any of these alarms has been caused.

400   Overload signal is on for n-axis.

401   Servo amplifier ready (DRDY) signal is off for n-axis.

404   DRDY signal is not turned off despite that MCON (n-axis ready)
       signal has been turned off.   Or DRDY signal is on despite that
       MCON signal has not been turned on when power was turned
       on.

V-8

405   Machine axes may not have been returned to their origins
        properly due to servosystem or CNC irregularity.

407   Positional deviation of simultaneously controlled machine axis
        is larger than set data.

410   n-axis positional deviation is larger than set data when
        stopped.

411   n-axis positional deviation is larger than set data during travel.

413   Sum of n-axis positional deviations has exceeded $\pm 2^{31}$.   (This
        alarm is caused normally due to parameter setting error.)

414   Alarm condition has been caused in n-axis digital servosystem.

415   Velocity of over 511875 detection units per second has been
        instructed to n-axis.   (This alarm is caused due to error in
        CMR parameter setting.)

416   Irregularity (wire breakage, etc.) has been caused in n-axis
        pulse-coder's position detection system.

417   Error has been found in parameter setting for n-axis digital
        servosystem.

OVERTRAVEL ALARMS

If any of these alarms has been caused, correct the condition as
described below.

500   n-axis has traveled beyond stored stroke limit "1" in plus
        direction.

501   n-axis has traveled beyond stored stroke limit "1" in minus
        direction.

502   n-axis has traveled beyond stored stroke limit "2" in plus
        direction.

503   n-axis has traveled beyond stored stroke limit "2" in minus
        direction.

506 n-axis stroke limit switch on plus side has been actuated.

507 n-axis stroke limit switch on minus side has been actuated.

(A) If the NC READY light is out and the cause of the alarm is an overtravel of the X- or Y-axis, take the following steps:
1. Change CNC mode to MANUAL.
2. Press and hold OT RELEASE button, lighting NC READY light. Then press required FEED button to retract overtraveled axis while still holding OT RELEASE button.
3. Release buttons. (NC READY light should remain lighted at this time.)
4. Press Reset key.
5. Return all machine axes to their origins, modify program, and restart operation again from beginning.

(B) If the NC READY light is on and the cause of the alarm is an overtravel of the Z-axis, take the following steps:
1. Change CNC mode to MANUAL.
2. Press either +Z or –Z button to retract Z-axis.
3. Press Reset key.
4. Return all machine axes to their origins, modify program, and restart operation again from beginning.

(C) If the NC READY light is on and the cause of the alarm is an overtravel of the B-axis, take the following steps:
1. Change CNC mode to MANUAL.
2. Press and hold OT RELEASE button and SWITCH ENABLE button. Then press either +B or –B button to retract B-axis.
3. Press Reset key.
4. Return all machine axes to their origins, modify program, and restart operation again from beginning.

OVERHEAT ALARM

Contact AMADA if this alarm has been caused.

700 Master printed circuit board is overheated.

SYSTEM ALARMS

Contact AMADA if any of these alarms has been caused.

900 Parity error has been caused in ROM.

910 Parity error has been caused in RAM.

911   Parity error has been caused in RAM.

912   Parity error has been caused in RAM.

913   Parity error has been caused in RAM.

920   Servosystem error has been caused for 1st or 2nd axis.

921   Servosystem error has been caused for 3rd or 4th axis.

924   Digital servo module has not been installed.

930   Abnormal interrupt error has been caused in CPU.

950   PMC has irregularity.

951   PMC-RC has irregularity.

970   RAM parity error or NMI error has been caused in PMC-RA2 or PMC-RB.

971   SLC communication error has been caused in PMC-RA1, PMC-RA2 or PMC-RB.

972   NMI error has been caused in board other than main CPU board.

973   Unidentified NMI error has been caused.

LASER ALARMS

Return all the machine axes to their origins after removing the cause of a laser alarm and then restart the operation from the beginning.

4052   Too large or small value for nozzle gap.   This can occur from G32 instruction with "R" value too big or small, or bad data in processing condition file.   Correct program and/or processing condition file and resume manufacture.   (For alterations to processing condition file, remember to SAVE your changes!)

> ### NOTE
> ● This message may be misleading, because you shouldn't have G13 in your part-program.   Just check program's G32 and processing condition file for incorrect values.

4060   Allowance for Z-axis tracking sensor is excessive.   (Press Reset key.)

4061   AD converter–1 has irregularity.   (Contact AMADA.)

4062   AD converter–2 has irregularity.   (Contact AMADA.)

4063   RF–DC power source has irregularity.
        Take following steps to correct condition:
        1. Turn off LASER keyswitch.
        2. Turn off CNC and then turn off machine and laser oscillator
           circuit breaker switches.
        3. Turn on laser oscillator and machine circuit breaker
           switches, and then turn on CNC.
        4. Turn on LASER keyswitch.
        5. Contact AMADA if same alarm is caused again.

4065   Shutter has irregularity.   (Contact AMADA.)

4066   Some discharge tubes are not functioning.   (Contact
        AMADA.)

4067   Temperature in laser oscillator has greatly increased.   (Press
        Reset key and take necessary steps to lower ambient
        temperature.)

4068   Discharged CO_2 laser beam had been reflected back into
        resonator.   (Press Reset key and decrease laser output.)

4069   Laser interface printed circuit board has irregularity in power
        supply.   (Contact AMADA.)

4070   Cooling unit is not ready for operation.   (Press Reset key and
        turn on cooling unit.)

4071   Assist gas supply is not ready for operation.   (Press Reset key
        and check remaining pressure in cylinder.)

4072   Cooling water flow has been reduced.   (Press Reset key,
        change cooling water, and clean strainers.)

4073   Laser gas pressure is low.   (Press Reset key and check
        remaining pressure in cylinder.)

4074   Gas blower is overheated.   (Contact AMADA.)

4075   Cooling water temperature is too low and dew is formed on
        piping in RF–DC power source.   (Press Reset key and turn off
        LASER keyswitch.   Then set temperature at 27 to 28°C, or 81
        to 82°F, and operate cooling unit independently for 10 to 20
        minutes to remove dew.)

4076 CO_2 laser output has been reduced.   (Contact AMADA.)

4077   Laser beam absorber is overheated.   (Contact AMADA.)

4078   Laser gas pressure in discharge tube is not normal.   (Contact AMADA.)

4079   Emergency stop condition has been caused.   (Remove cause of stop and press Reset key.)

4080   There is laser gas leakage in discharge tube or gas piping. (Contact AMADA.)

4081   Required pressure has not been obtained inside discharge tubes in given time.   (Contact AMADA.)

4082   Negative pressure sensor has irregularity.   (Contact AMADA.)

4083   Shutter is not opened.   (Contact AMADA.)

4085 CO_2 laser output has been reduced.   (Press Reset key. Then contact AMADA to have mirrors in laser oscillator cleaned.)

4087   Shutter mirror temperature has risen.   (Contact AMADA.)

4088   Discharge tube voltage has been reduced.   (Press Reset key, and check and correct composition of laser gas.)

4090   LASER keyswitch is turned to OFF.   (Press Reset key and turn LASER keyswitch to ON.)
Or HIGH VOLTAGE light is not on.   (Press Reset key.)

4091   Inverter circuit has problem.   (Contact AMADA.)

4094   Vacuum pump has problem.   (Contact AMADA.)

4095   AD converter–3 has irregularity.   (Contact AMADA.)

4106   Level of gas blower oil has been reduced.   (Contact AMADA.)

MACHINE ALARMS

The ALARM light comes on when an alarm is caused with the machine. (The light will blink when any of the alarms numbered 2289 to 2299 occurs.) The alarm can be identified by showing the OPERATOR MESSAGE display — press the Message key and then press the MSG softkey. Clear the alarm as described below.

2100   MAIN AIR PRESSURE DOWN

Compressed air is not supplied at all or the operating air pressure has dropped below 0.42 MPa (60 psi or 4.2 kgf/cm²). Remove the cause to bring the pressure up to 0.5 MPa (72 psi or 5 kgf/cm²), and then press the Reset key.

2101   CIRCUIT PROTECTOR TRIP

A circuit protector in the electrical control unit has been tripped due to an overload or short circuit in the 100 V AC or 24 V DC circuit. Remove the cause and then press the Reset key. (Contact AMADA if the same alarm recurs.)

2102   DEADZONE

One of the workclamps has entered the dead zone, in which it is likely to collide with the laser head. Shift the Y-axis in the plus direction in the MANUAL mode and then press the ALARM RESET button. Then change the cutting starting point or correct the program.

2103   SAFETY STOP

The optical safety device has been actuated. Or the collimator box cover is open. Remove the cause and then press the SAFETY DEVICE RESET button, turning on the SAFETY DEVICE READY light.

2104   CUTTING HEAD CONNECTION (HEAD JOINT)

The laser head is not properly locked. Correct the position of the limit switch which has detected the condition, lock the head in place, and then press the Reset key.

2106   SHUTTLE SAFETY STOP

The shuttle table interlock device (e.g., optical safety device) has been actuated during a pallet change. Remove the cause and then press the SAFETY DEVICE RESET button on the shuttle table side, turning on the SAFETY DEVICE READY light.

2116   INTERLOCK +Z

The Z-axis has overtraveled upward. Change the CNC mode to MANUAL and then press the –Z button to retract the axis downward.

2117   INTERLOCK –Z

The Z-axis has overtraveled downward. Change the CNC mode to MANUAL and then press the +Z button to retract the axis upward.

2118   INTERLOCK +B

The B-axis has overtraveled upward. Change the CNC mode to MANUAL. Then press and hold the OT RELEASE button and the SWITCH ENABLE button, and press the –B button to retract the axis downward.

2119   INTERLOCK –B

The B-axis has overtraveled downward. Change the CNC mode to MANUAL. Then press and hold the OT RELEASE button and the SWITCH ENABLE button, and press the +B button to retract the axis upward.

2120   NOZZLE HOLDER

The nozzle unit is not properly mounted on the laser head. Mount the unit correctly.

2123   BEAM COVER OPEN

The alignment work doors installed in two positions in the partition are open. Close them to clear the alarm.

2125   SCRAP BOX

The scrap box has been withdrawn. Return it to clear the alarm.

2132   BEND MIRROR 1 INTERLOCK

The first bend mirror unit or Active Cut mirror unit (option) located above the laser head is not properly installed. Install the unit correctly.

2133   BEND MIRROR 2 INTERLOCK

The second bend mirror unit is not properly installed. Contact AMADA.

2136   BEND MIRROR 5 INTERLOCK

The third, fourth, or fifth bend mirror unit is not properly installed. Contact AMADA.

2149   WORK CLAMP OPEN

An attempt has been made to operate the laser cutting machine when the optional pneumatic workclamps are open or to change a pallet when the pneumatic workclamps of either the laser cutting machine or the shuttle table are open.   Close the pneumatic workclamps to clear the alarm.   With the pneumatic workclamps closed, operate the laser cutting machine or change the pallet.

2154   SENSING ALARM

The Z-axis tracking sensor failed to position the Z-axis four times.   Raise the Z-axis in the MANUAL mode and then press the ALARM RESET button.   (Contact AMADA if the same alarm recurs.)

2155   BEAM REFLECTING

The discharged CO_2 laser beam had been reflected back into the laser oscillator.   Press the Reset key and then reconfirm laser cutting conditions.

2158   SHUTTER ENABLE KEY

The SHUTTER keyswitch is turned on but a high-voltage has not been supplied to the laser oscillator.   Turn off the switch.

2159   ASSIST GAS NOT SELECTED

The assist gas is not specified in the program.   Press the Reset key, and then correct the program or processing condition file.

2160   ASSIST GAS PRESSURE BELOW MINIMUM

The assist gas pressure has dropped below 0.02 MPa (2.8 psi or 0.2 kgf/cm²).   Inspect the amount of assist gas in the cylinder, and then press the ALARM RESET button.   Then have the supplier change the cylinder.

2161   DUST COLLECTOR OVERHEAT

The overheat signal has been received from the dust collector unit — the cutting operation will not be stopped until the ongoing process is completed, however.   Remove the cause of the alarm by referring to the dust collector unit manual, and then press the ALARM RESET button.

2162   DUST COLLECTOR OVERLOAD

The overload signal has been received from the dust collector unit — the cutting operation will not be stopped until the ongoing process is completed, however.   Remove the cause of the alarm by referring to the dust collector unit manual, and then press the ALARM RESET button.

2164   EZ CUT

The filter for the EZ-cut accessory has clogged — the cutting operation will not be stopped until the ongoing process is completed, however.   Press the ALARM RESET button and then change the filter.

2165   FREE BEARING UP

The foot switch pedal was pressed to close the workclamps with the free-motion ball bearings raised.   Press the FREEBEAR DOWN button.   Then press the foot switch pedal again and press the ALARM RESET button.

2166   CHILLER ALARM

An alarm condition has occurred in the cooling unit.   (Supply of a high-voltage to the laser oscillator will then stop.)
Remove the cause of the alarm by referring to the cooling unit manual.

2167   SCRAP CONVEYOR OVERLOAD

The overload signal has been received from the chip conveyor. The ongoing operation will not be stopped at this time.   Press the CONVEYOR AUTO button to turn off its light, remove the cause, and then press the ALARM RESET button.

2170   RESTART PROGRAM PMC AXIS ALARM

One of the servosystem or overtravel alarms has occurred when operating the Z-axis tracking sensor.   Remove the cause of the alarm and then press the Reset key.

2193   Z-SENSOR WIRE BREAK

This alarm may be caused by any of the following.   (Contact AMADA if the same alarm recurs after removing the cause.)
When the sensor is not used for operation, press to light the TRACE OFF button.

a. Loose nozzle
    Tighten the nozzle.

b. Dirt around the nozzle (insulation is weakened)
    Clean the tip of the nozzle and the threads between the lower head assembly and the sensor cone assembly.

c. Loose connection
    Check that the cable is inserted securely at the connector on the sensor cone.

d. Wiring problem inside the sensor cone
    Replace the sensor cone.

2194   TRACE ERROR

The laser head has been raised more than 30 mm (1.2") from the instructed nozzle tip height during the Z-axis tracking.   Or the laser beam has been emitted where the laser head is located more than 30 mm (1.2") from the instructed nozzle tip height.   Press the TRACE OFF button to turn off its light.

2197   SHUTTER OPEN PROGRAM ERROR

M00, M10, M80 or M180 has been commanded when the laser shutter is open.   Press the Reset key and then correct the program.

2199   OVS PROGRAM ERROR

OVS measurement has been commanded when the work chute is open or the reposition command is being executed. Press the Reset key and then correct the program.

2202   CALIBRATION FAILED

The Z-axis tracking control data table has not been created. Press the Reset key.

2203   CALIBRATION TIME OVER

The Z-axis tracking sensor has not been calibrated in a predetermined time.   Press the Reset key.

2205   OVS DEAD ZONE

OVS measurement has been commanded in the area where one of the workclamps may interfere with the OVS cylinder. Press the Reset key and then correct the program to change the OVS measurement position.

2206   OVS CUTTING CONDITION IS WRONG

The number of cutting errors counted by the OVS cutting condition monitoring function has exceeded the preset number. Press the ALARM RESET button and then remove the causes of the cutting errors.   Before restarting the operation, reset the "Badness Detection Detect. Num." on the AIV SETTING display.

2207   OVS SCRAP DROP FAILURE

Scrap dropping failure has been detected by the OVS.
Remove the scrap and then press the ALARM RESET button.

2208   OVS EXCESSIVE ERROR OF MEASUREMENT

The object measured is out of position by more than the permissible error set by the OVS hole-pitch error measuring function.   Press the ALARM RESET button.   Compare the measured error ("Pitch Measuring Error X or Y") with the permissible error ("Pitch Measuring Err Allow.") — they are shown on the AIV SETTING display.   Measure the amount of error by another method to check that the object is actually displaced.

2211   WORK SET NOT READY

When the light of the WORK SET button is not turned on, a command has been issued for making a pallet change in the AUTO or MDI mode.   Press the WORK SET button, and restart the line.

2212   WORK HOLD FAILED

Completion of M10 is not signaled.   Or a code not used on the machine is specified.   Press the Reset key and then contact AMADA.

2213   WORK CLAMP FAILED AT REPOSITION

Completion of M11 is not signaled.   Or a code not used on the machine is specified.   Press the Reset key and then contact AMADA.

2214   WORK CLAMP FAILED

The workclamp opening/closing operation has not been completed in a predetermined time.   Press the Reset key or the ALARM RESET button and then contact AMADA.

2216   WORK CHUTE OPEN FAILED

Completion of M80 is not signaled.   Or a code not used on the machine is specified.   Press the Reset key and then contact AMADA.

2217   WORK CHUTE CLOSE FAILED

Completion of M81 is not signaled.   Or a code not used on the machine is specified.   Press the Reset key and then contact AMADA.

2218   WORK CHUTE CYCLE FAILED

Completion of M180 is not signaled.   Or a code not used on the machine is specified.   Press the Reset key and then contact AMADA.

2219   SHUTTER OPEN FAILED

Completion of M760 is not signaled.   Press the ALARM RESET button and then contact AMADA.

2220   SHUTTER CLOSE FAILED

Completion of M762 is not signaled.   Press the ALARM
RESET button and then contact AMADA.

2221   FREE BEARING SWITCHING FAILED

The free-motion ball bearing up/down operation has not been
completed in a predetermined time.   Press the ALARM
RESET button and then contact AMADA.

2222   RESTART PROGRAM FAILED

The Z-axis has not been positioned by using its tracking sensor
in a predetermined time.   Press to light the TRACE OFF
button, press the ALARM RESET button, and then contact
AMADA.

2225   CHILLER FAILED

The cooling unit start completion signal has not been returned
in a predetermined time.   Turn the LASER keyswitch to OFF
and then contact AMADA.

2228   OVS FAILED

OVS measurement has not been completed in a
predetermined time.   Press the Reset key.   If the alarm
recurs, contact AMADA.

2229   DUST COLLECTOR FAILED

A start completion signal has not been returned within a
predetermined time after the start of the dust collector.   Press
the ALARM RESET button to clear the alarm.   When the
alarm is caused during a cutting operation, it will be displayed
after the end of the cutting operation.   Contact the AMADA
service engineer.

2230   PALLET ORIGIN LOCK FAILED (SHUTTLE)

When a pellet is fixed on the laser cutting machine, an
operation completion signal has not been returned within a
predetermined time.   Press the ALARM RESET button to
clear the alarm.   Cylinder trouble, for example, is suspected.
Contact the AMADA service engineer.

2231   PALLET HOME LOCK FAILED (SHUTTLE)

When a pallet is fixed on the shuttle table, an operation
completion signal has not been returned within a
predetermined time.   Press the ALARM RESET button to
clear the alarm.   Cylinder trouble, for example, is suspected.
Contact the AMADA service engineer.

2233   SAFETY SHUTTER FAILED

The partition safety shutter (vertical sliding door) has not operated as specified by its up or down command.

Cylinder trouble, for example, is suspected.   Contact the AMADA service engineer.

2236   BEND MIRROR 1 MICRO SW. WELD

The first bend mirror unit or Active Cut mirror unit (option) has been removed when either of the limit switches that detect the installation condition of the unit is faulty.   (If this alarm occurs when the bend mirror unit is installed, the electric circuit has a problem.)   Press the ALARM RESET button and then contact AMADA.

2237   BEND MIRROR 2 MICRO SW. WELD

The second bend mirror unit has been removed when either of the limit switches that detect the installation condition of the unit is faulty.   (If this alarm occurs when the bend mirror unit is installed, the electric circuit has a problem.)   Press the ALARM RESET button and then contact AMADA.

2240   BEND MIRROR 5 MICRO SW. WELD

The third, fourth, or fifth bend mirror unit has been removed when either of the limit switches that detect the installation condition of the unit is faulty.   (If this alarm occurs when the bend mirror unit is installed, the electric circuit has a problem.)   Press the ALARM RESET button and then contact AMADA.

2241   ACTIVE MIRROR

The PZT-type Active Cut unit (option) is faulty.   Press the ALARM RESET button to clear the alarm.   Contact the AMADA service engineer.

2242   WACS HEAD HOLDER

A WACS command is specified when the WACS head is not installed.   Press the Reset key to clear the alarm.   Install the WACS head or correct the program.

2244   PALLET POSITION (SHUTTLE)

The AUTO mode has been selected without meeting the
following conditions:

· A pallet is locked on the laser cutting machine.
· The pallet hook is turned off (lowered).
· The traverser forward or backward end limit
  switch is turned on.
· A pallet sensor of the shuttle table is turned on.

Change to the MANUAL mode to clear the alarm.   Manually
operate the line to meet the above conditions.

2245   INVERTER ALARM (SHUTTLE)

The traverser forward/backward inverter has fallen in the alarm
condition.
Check the inverter display in the electrical control cabinet of the
shuttle table, remove the cause of alarm, and reset the CNC
unit.

2246   PALLET FEED FAILED

An operation completion command has not been returned
within a predetermined time after a pallet change command.
Press the ALARM RESET button to clear the alarm.   Contact
the AMADA service engineer.

2247   SAFETY SHUTTER OPEN

The CNC mode has been changed to AUTO or MDI when the
partition safety shutter is open.   Change the CNC mode to
MANUAL and then close the safety shutter.

2248   SAFETY SHUTTER CLOSE

An attempt has been made to make a pallet change manually
when the partition safety shutter is closed.   Press the ALARM
RESET button to clear the alarm.   Open the safety shutter and
then make the pallet change manually.

2249   PALLET LIFTER FAILED (SHUTTLE)

A shuttle table lifter operation completion signal has not been
returned within a predetermined time.   Press the ALARM
RESET button to clear the alarm.   Contact the AMADA
service engineer.

2250   TABLE CIRCUIT PROTECTOR TRIP (SHUTTLE)

Overcurrent has flowed to the traverser or lifter motor.
The motor may be overloaded or otherwise faulty.   Contact
the AMADA service engineer.

2251   PALLET CHANGE NOT READY

The pallet change command (M707) has been specified except
when the free-motion ball bearings are in the lower position
and the Z-axis is in the zero-return position.   Press the Reset
key to clear the alarm.

2279   NO CUTTING CONDITION FILE

None of the processing condition files are stored in the CNC
memory.   Press the Reset key.   Then register a file name and
set the conditions, or read the files from the accessory backup
floppy disk.

2280   NO MATERIAL REGISTERED

The processing condition file specified by the M102 command
is not stored in the CNC memory.   Press the Reset key.
Then register the file name and set the conditions, or correct
the program.

2281   EMS DOES NOT SUPPORT

The expanded memory is not installed or the parameter setting
is incorrect.   Contact AMADA.

2282   DATA RECOVERY

The processing condition file is now being restored because
the data in the file has been destroyed during the program
execution.

2283   PMC/CNC WINDOW MALFUNC

An abnormality has occurred during the PMC-CNC mode
switching.   Turn off the LASER keyswitch and CNC, and then
turn them on again in the reversed order.

2289   NC BATTERY LOW

The CNC memory backup cell voltage has been reduced —
the ongoing operation will not be stopped at this time.
Change the cells by referring to Part VI, Maintenance.

2290   LASER ALIGNMENT MODE

The LASER ALIGNMENT keyswitch in the electrical control
unit has been turned on.   (Laser cutting cannot be performed.)
Turn off the LASER keyswitch, CNC, machine circuit breaker
switch, and then LASER ALIGNMENT keyswitch.

2291   X-AXIS SYNCHRONOUS CONTROL OFF

Warning: This is a maintenance setting used only by the
AMADA service engineer.   The X-axis is in the synchronous
adjustment condition.   Clear the setting to clear the warning.

2292   MACHINE INSPECTION MODE

The MACHINE INSPECTION keyswitch in the electrical control unit has been turned on.   Turn off the LASER keyswitch, CNC, machine circuit breaker switch, and then MACHINE INSPECTION keyswitch.

2294   EMERGENCY STOP

Warning: This is a maintenance setting used only by the AMADA service engineer.   The laser cutting machine has been stopped in an emergency when the alarm trap function is turned on.   Remove the cause of the emergency stop and then press the ALARM RESET button to clear the warning.

2295   LASER GAS EMPTY

The pressure reduction signal for the laser gas cylinder has been received from the laser gas residual pressure monitor (optional).   Change the laser gas cylinder.

2297   PROGRAM CHECK MODE

The program check function is effective with the PROGRAM CHECK button light on.   Press the PROGRAM CHECK button to turn off its light and disable the function.

2298   REFERENCE POSITION UNFIXED

The change of the data input unit, from the metric system to the inch system and vice versa, has made the coordinate origin position uncertain.   Change the CNC mode to RETRACT and then zero-return all the machine axes.   If the machine is equipped with the B-axis, also zero-return the B-axis.

2299   MANUAL CUT MODE

The manual cutting mode is effective with the MANUAL CUT keyswitch set at ON.   Turn the MANUAL CUT keyswitch to OFF to disable the manual cutting mode.

Part VI

Maintenance

Contact AMADA for information on the maintenance of any parts or items which are not described in this Part.

⚠ WARNING	● Turn off the machine and laser oscillator circuit breaker switches, the supply of compressed air, and then the shop circuit breaker switch during an inspection or maintenance work. Then padlock the machine and laser oscillator circuit breaker switch levers and the air intake valve at the air system.
	● When working inside the hazardous area around the machine, press the STOP buttons on the CNC control panel and the shuttle table control panel. Then turn the SHUTTER keyswitch to OFF, remove the key from the switch, and hold it by yourself — to prevent the machine from being started by mistake.

DAILY MAINTENANCE

Carry out the maintenance routine described below before starting the day's operation.

Cleaning

Inspect the following parts and clean them if necessary as described below:

- Z-axis guide rails:
  Clean them by using an air gun.
- Laser head lens:
  See page VI-12, "Cleaning," for the cleaning procedure.
- Laser head nozzle & Z-axis tracking sensor:
  See page VI-12, "Cleaning," for their cleaning procedure.
- Chip conveyor (option):
  Clean it if provided.

Partition doors

Check that the acrylic partition doors are not cracked or broken.   If cracked or broken, ask AMADA to change with new ones.

Controls

Check that the EMERGENCY STOP buttons and interlocks work properly.   If not, ask AMADA to repair.

Noise

Confirm that the servomotors operate without irregular noise.

Skids

Inspect the skids installed on the machine table and change them if damaged.

Cooling unit

Inspect the cooling unit as follows (refer to the separate manual for the unit):

- Check the level of water in the tank and replenish water, if necessary. The water must be cleaned through a purifier before filling in the tank.
- Check the flow of cooling water in the laser oscillator and the machine. Regulate the flow on the cooling unit, if necessary.

Laser gas supply

Inspect the amount of laser gas in the cylinder. Open the cylinder's main valve and read the primary pressure gauge on the regulator attached to the cylinder. Change the cylinder if the reading is below 1 MPa (10 kgf/cm²).
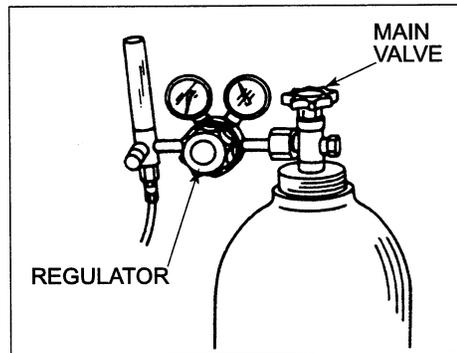
Assist gas supply

Inspect the amount of assist gas in the cylinder. Check the cylinder's level gauge. Change the cylinder if the level is low.

⚠ CAUTION	● Have the supplier change the assist gas cylinder.

Air system

- Supply the required compressed air and open the air intake valve. Then inspect the operating air pressure on the regulator and adjust it to 0.5 MPa (5 kgf/cm²) if necessary by using the regulator knob.
- Check to ensure that the air piping is free of damage or loosened couplings, and leakage.
- Inspect the level of oil in the lubricator, which should be between the upper and lower levels shown on the level gauge, and replenish a specified oil* if necessary.
  *AMADA A-32, MOBIL DTE Oil Light or SHELL Tellus Oil C32.

Laser oscillator
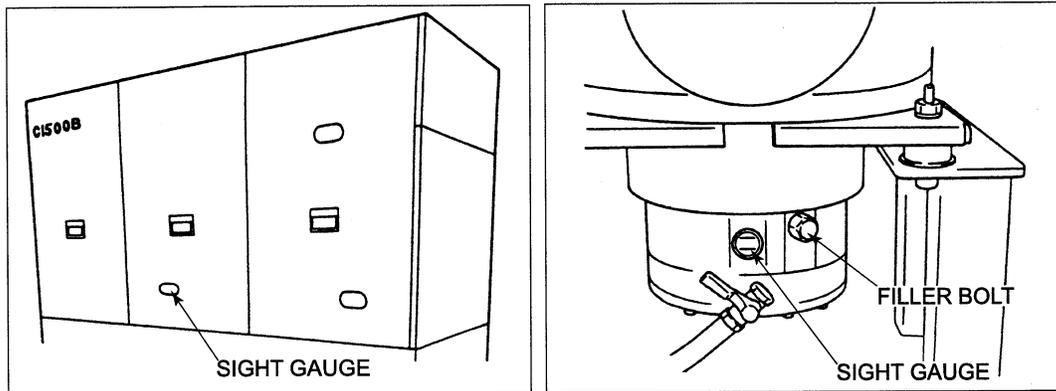
Turn off the laser oscillator circuit breaker switch and inspect the level of oil in the gas blower, which should be between the MAX and MIN lines on the sight gauge. Replenish the specified oil (FANUC A04B-0800-K326) as described below if the level is low.

⚠ WARNING	● If the gas blower tank is overfilled, the gas blower may be damaged.

1   Turn off the shop circuit breaker switch.

2   Wait at least for 5 minutes after the gas blower has stopped.

3   Remove socket head bolts from the side covers and detach the covers — they are on the left side viewed with the oscillator circuit breaker switch in front.

4   Remove the filler bolt together with its O-ring using a 17 mm-size wrench.

5   Fill the oil from the filler up to a level between the MAX and MIN lines on the sight gauge. The tank has a capacity of 150 ml.

6   Clean the filler and its bolt and O-ring by using a dry cloth.

NOTICE

● Inspect the O-ring of the filler bolt and change it if it is deteriorated.

7   Correctly attach the O-ring to the filler bolt, install and tighten the bolt, and then replace and clamp the side covers.

PERIODICAL MAINTENANCE

Carry out maintenance operations periodically in addition to the daily maintenance routine. There are two sets of scheduled maintenance operations as described below — Schedule 1 and Schedule 2.

Carry out scheduled periodical maintenance operations according to both schedules without fail. If the same item is listed in both schedules, carry out the operation according to the schedule which comes earlier than the other.

Schedule 1

This set of maintenance operations is scheduled by calendar periods.

Once every week

- Inspect the rack and pinion of the X-axis and the ball screws of the Y- and Z-axes, clean them by using an air gun, and apply a specified oil* lightly if necessary.

  *SHELL Stamina EP Grease 2 for the rack and pinion of the X-axis, and AMADA Grease No.2, MOBIL Mobilux 2 or SHELL Alvania 2 for the ball screws of the Y- and Z-axes.

- Inspect the dust collector unit filter and clean it if necessary (refer to the separate dust collector unit manual).

⚠ WARNING	● Don't use cleaning oil or rust-preventive for cleaning the filter — it can ignite during laser-cutting.

- Inspect the quality of water in the cooling unit tank and change the water if necessary (refer to the separate cooling unit manual).

- Check to ensure that the piping and cables are free of damage or loosened connections.

⚠ WARNING	● Turn off the shop circuit breaker switch and wait for five minutes before detaching the side covers of the laser oscillator (on the left side with the oscillator circuit breaker switch in front) — when inspecting the following two devices in the oscillator.

- Inspect the level of oil in the oscillator vacuum pump, which should be between the MAX and MIN lines on the sight gauge, and change the oil if the level is low. See page VI-16, "Replacements."

NOTICE

● Check to see the degree of deterioration of the oil at the same time — change it if it is not clear and has a darkish appearance. Also check for oil leakage from the vacuum pump and the drain cock — contact AMADA for a change of the vacuum pump exhaust filter if leakage is found.

- Check for oil leakage from the oscillator gas blower and its drain cock — contact AMADA if leakage is found.

DRAIN COCK · SIGHT GAUGE · (VACUUM PUMP)

DRAIN COCK · (GAS BLOWER)
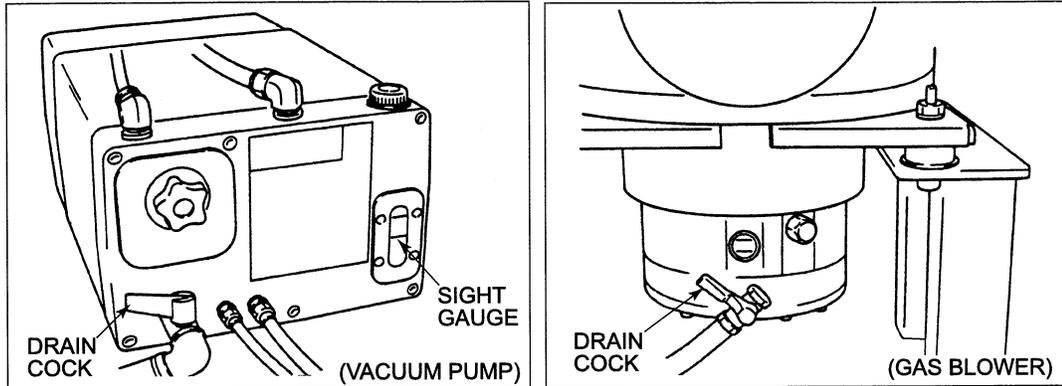
Once every month

- Lubricate machine parts.   See page VI-10, "Lubrication."
- Inspect the bend mirror located above the laser head and clean it if necessary.   See page VI-12, "Cleaning."
- Clean the strainers incorporated in the cooling water piping.   See page VI-12, "Cleaning."
- Inspect the O-ring between the Z-axis tracking sensor and nozzle holder and change the O-ring if it is deteriorated.   See page VI-16, "Replacements."
- It is necessary to clean the bend mirrors located between the laser oscillator and the machine proper — contact AMADA for the cleaning.
- Clean the air filters on the CNC and electrical control units.   See page VI-12, "Cleaning."
- Clean the optical axis air filter at the right side of the front cover.   See page VI-12, "Cleaning."
- Change the cooling water (refer to the separate cooling unit manual).

Once every 3 months

- Change the skids installed on the machine table.

Once every 4 months

- Change the oil in the gas blower in the laser oscillator.   See page VI-16, "Replacements."

Once every 6 months

- Change the oil in the vacuum pump in the laser oscillator. See page VI-16, "Replacements."
- Inspect the air filter of the air system and change it if it is contaminated. See page VI-16, "Replacements."
- It is necessary to clean the mirrors inside the laser oscillator — contact AMADA for the cleaning.
- It is necessary to change the exhaust system filter in the laser oscillator — contact AMADA for the change.

Once every 12 months

- Change the CNC memory backup cell inside the CNC control unit. See page VI-16, "Replacements."
- It is necessary to clean the inside of the cooling water piping for the laser oscillator — contact AMADA for the cleaning.
- It is necessary to change the bend mirrors which are located above the laser head and between the laser oscillator and the machine proper — contact AMADA for the change.
- It is necessary to change the mirrors inside the laser oscillator — contact AMADA for the change.
- It is necessary to change the vacuum pump exhaust filter in the laser oscillator — contact AMADA for the change.
- When the optional focal point CNC control is provided, change the B-axis coordinate value backup cells inside the electrical control unit. See page VI-16, "Replacements."

Once every 24 months

- It is necessary to change the pressure controller gas filter and discharge tube O-rings in the laser oscillator — contact AMADA for the change.

Once every 36 months

- It is necessary to overhaul the vacuum pump in the laser oscillator — contact AMADA for the overhaul.

Once every 48 months

- It is necessary to overhaul the gas blower in the laser oscillator — contact AMADA for the overhaul.

Schedule 2

This set of maintenance operations is scheduled by hours of actual machine operation.

Every 200 hours

- Inspect the bend mirror located above the laser head and clean it if necessary.   See page VI-12, "Cleaning."
- Clean the air filters on the electrical control unit.   See page VI-12, "Cleaning."
- Clean the strainers incorporated in the cooling water piping.   See page VI-12, "Cleaning."
- It is necessary to inspect and adjust the amount of oil applied by the air system lubricator — contact AMADA for the inspection and adjustment.
- It is necessary to clean the bend mirrors located between the laser oscillator and the machine proper — contact AMADA for the cleaning.

Every 1000 hours

- Inspect the machine for loosened bolts and nuts and retighten them if loosened.
- Change the oil in the gas blower in the laser oscillator.   See page VI-16, "Replacements."

Every 1500 hours

- Change the oil in the vacuum pump in the laser oscillator.   See page VI-16, "Replacements."
- It is necessary to change the exhaust system filter in the laser oscillator — contact AMADA for the change.

Every 3000 hours

- It is necessary to change the vacuum pump exhaust filter in the laser oscillator — contact AMADA for the change.
- It is necessary to change the warning light on the laser oscillator — contact AMADA for the change.

Every 10000 hours

- It is necessary to overhaul the vacuum pump in the laser oscillator — contact AMADA for the overhaul.

Every 12000 hours

- It is necessary to overhaul the gas blower in the laser oscillator — contact AMADA for the overhaul.

Maintenance Addendum For FO Series Laser Machines With Fanuc C4000 Series Resonator

Every 800 to 1200 hours

- Cleaning of Output and Rear mirrors only

Every 3000 to 4000 hours

- Cleaning of all internal mirrors

LUBRICATION

Lubricate machine parts or change lubricants as specified in this section. Carry out lubrication and lubricant changes in the daily and periodical maintenance operations as scheduled in the list shown below — the numbers in the list identify the locations in the drawings shown on the next page:

SPECIFIED LUBRICANTS

A: AMADA Grease No.2, MOBIL Mobilux 2, SHELL Alvania 2

B: SHELL Stamina EP Grease 2

C: FANUC A04B-0800-K326

D: FANUC A98L-0040-0093/1.0L6

NOTE

● For handling the lubricants and their chemical composition and other details, refer to the Appendix.

NO.	PART	LUB	FREQUENCY
1*	X-axis rack and pinion	B (grease nipple)	Once/month
2*	X-axis slider	A (grease nipple)	Once/month
3*	Y-axis ball nut	A (grease nipple)	Once/month
4*	Y-axis slider	A (grease nipple)	Once/month
5*	Y-axis bearings	A (grease nipple)	Once/month*
6*	Z-axis slider	A (grease nipple)	Once/3 months
7**	Z-axis ball nut	A (grease nipple)	Once/3 months
8	Laser oscillator gas blower	C (oil bath)	Change every 4 months or 1000 hours
9	Laser oscillator vacuum pump	D (oil bath)	Change every 6 months or 1500 hours

* Lubrication is very important for the trouble-free operation of the rack and pinion, ball nuts, sliders, and bearings.   Be sure to lubricate these parts in the following manner:

1. Apply a specified grease through the grease nipples by using a grease gun until the old grease is completely drained.
2. Remove the old grease from the guide rails and ball screws by using a clean and dry cloth.
3. Lightly apply the above specified grease to the guide rails and ball screws.

** Lubricate the Z-axis ball nut as follows:

1. Load a worksheet with a thickness of 6.0 mm or more on a shuttle-table pallet.
2. Deposit the shuttle-table pallet on the machine table.
3. Open the partition doors and step on the worksheet.
4. Remove the Z-axis cover and lubricate the Z-axis ball nut.
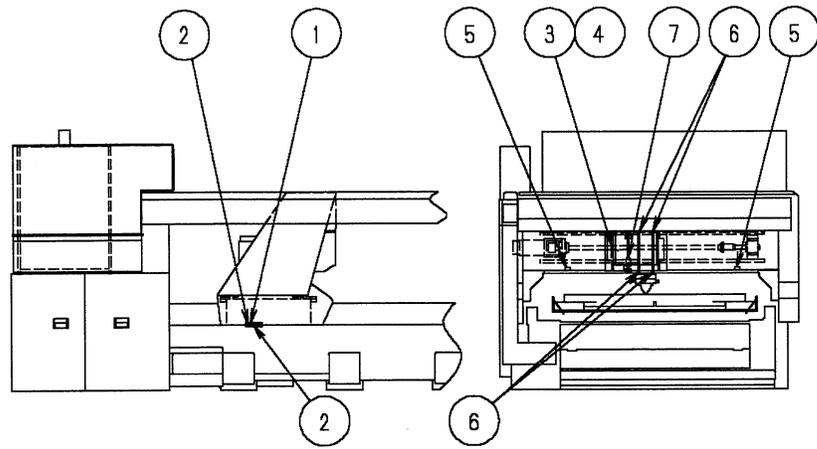
CLEANING

This section describes the cleaning procedures for the following parts:

- Lens
- Nozzle & Z-axis tracking sensor
- Bend mirror
- CNC & electrical control units' air filters
- Cooling water strainers
- Optical axis air filter

Lens

Clean the lens, if it is not clean, in the following manner:

⚠ CAUTION	● Do not touch the lens surfaces and handle the lens carefully to keep it intact.

1   Blow the dust off the lens surfaces by using clean and dry compressed air.

2   If the lens has not been made clean enough, then use a photographic lens cleaning tissue.   Fold the tissue into a small piece and damp it with pure ethyl alcohol or acetone.   Hold it by pincers and wipe the lens surface lightly in circular motion in one direction.   Repeat the step, if necessary, by changing the tissue.

LENS CLEANING TISSUE
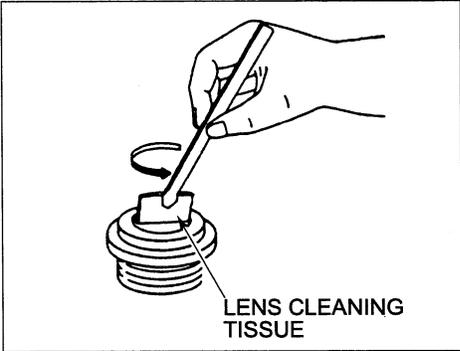
3   If the lens still has dirty spots, then use a cotton swab (100% cotton).   Damp it with acetone, remove the spots, and then repeat the above step.

Nozzle & Z-axis tracking sensor

Inspect the nozzle and Z-axis tracking sensor, and clean them if dirty, in the following manner:

1   Move the Y-axis to the end opposite to the origin, and lower the Z-axis to a position about 150 mm above the machine table in the MANUAL mode.

2   Turn off the shop circuit breaker switch.

3   Disconnect the Z-axis tracking sensor cable from the nozzle unit.

4   Pull out the nozzle unit lock bar, turn the unit counterclockwise (viewed from the bottom), and remove the unit.
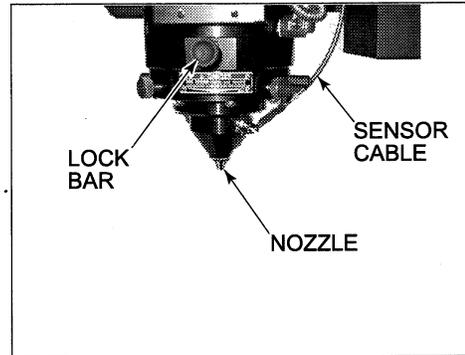
5   Inspect the nozzle and sensor, and clean them, if necessary.   If damaged, change them (refer to "Replacements" on page VI-16).

6   Replace the nozzle unit by turning it clockwise and then push in the lock bar.

7   Connect the Z-axis tracking sensor cable to the nozzle unit.

Bend mirror

Inspect and clean the bend mirror located above the laser head, if necessary, in the following manner:

NOTICE

● Do not touch the mirror surface and handle the mirror carefully to keep it intact.

1   Turn off the shop circuit breaker switch.

2   Pull and turn the two clamp levers to remove the bend mirror unit.

3   Blow the dust off the mirror surface by using clean and dry compressed air.
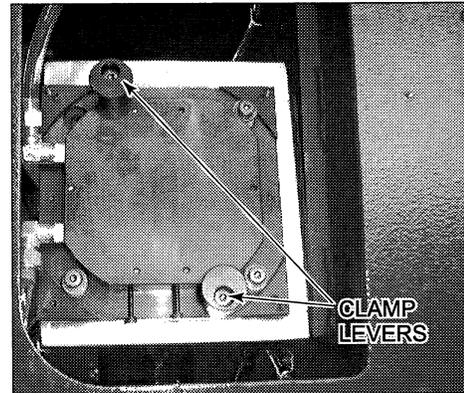
4   Fold a photographic lens cleaning tissue into a small piece, or use a cotton ball, and damp it with pure ethyl alcohol or acetone. Hold it by pincers and wipe the mirror surface lightly in circular motion in one direction.

5   Dry the wiped surface by blowing it with clean and dry compressed air.

6   Replace and clamp the bend mirror unit.

CNC unit & electrical control unit air filters

Clean the three air filters on the CNC and electrical control units in the following manner:

1 Turn off the shop circuit breaker switch.

2 Remove the filter.

3 Blow the dust off the inside of the filter by using compressed air.

4 If necessary, wash the filter gently in water by using a neutral detergent, rinse it, and then let it dry in the shade — do not wring the filter during the process.

5 Replace the filter.
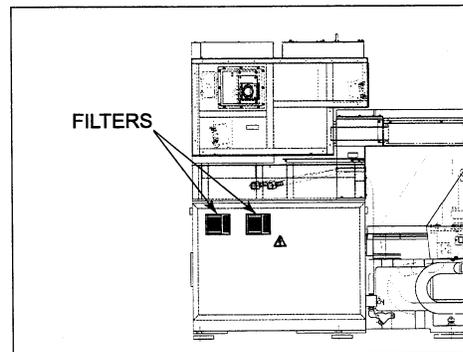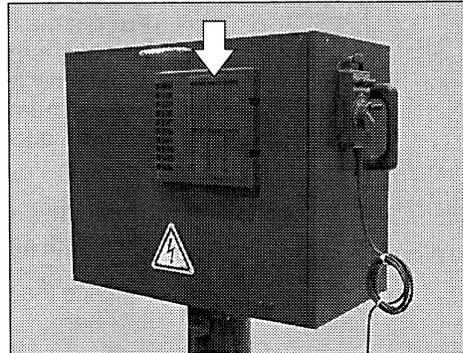
FILTERS

Optical axis air filter

The optical axis air filter is installed at the right side of the front cover to prevent dirty outside air from entering the optical path. Clean the filter, if it is clogged with dust, in the following manner:

1 Turn off the shop circuit breaker switch.

2 Remove the four right M6 bolts and remove the filter cover and the filter.

3 Blow the dust off the filter with an air gun.

4 Replace the filter.

5 Replace and clamp the filter cover.
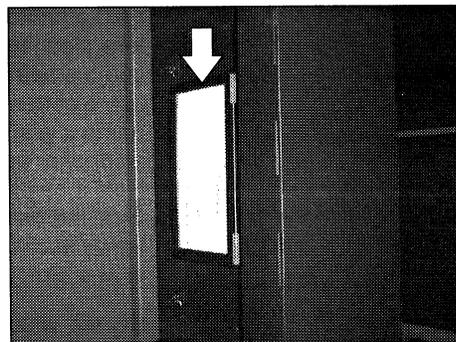
Cooling water strainers

Clean the two strainers — one in the feed pipe on the laser oscillator side and the other in the return pipe on the cooling unit side — in the following manner:

NOTE

● Clean the tank of the cooling unit also at this time.

1   Turn off the shop circuit breaker switch.

2   Drain the water from the cooling unit and clean the tank.   Refer to the separate manual for the unit for details.

3   Remove the strainer clamp bolt and then the strainer out of the pipe.

4   Clean the strainer of deposited sludge, etc. by using a brush.

5   Replace and clamp the strainer.

6   Refill the tank with the water obtained through a purifier.

STRAINER

CLAMP BOLT
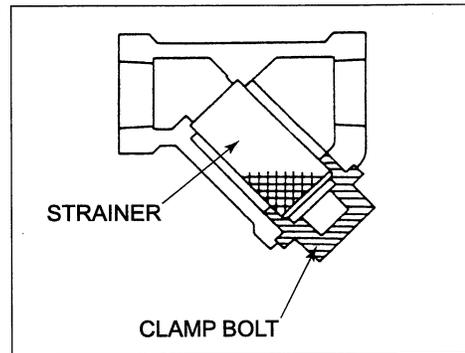
NOTICE

● Be sure to use the purified water.

REPLACEMENTS

This section describes the replacement procedures for the following parts:

- Laser gas cylinder
- Gas blower oil
- Vacuum pump oil
- Air system's air filter
- CNC memory backup cell
- Nozzle & Z-axis tracking sensor
- B-axis coordinate value backup cells (option)

Laser gas cylinder

Change the laser gas cylinder in the following manner:

⚠ CAUTION	● Keep people away from the regulator's pressure gauges when opening the main valve of the cylinder in Step 5 below. The face glass may be shattered and fly off if the regulator is damaged.

1   Turn off the shop circuit breaker switch.

2   Close the main valve of the currently used cylinder and then close the stop valve.

3   Turn the regulator knob to make the secondary pressure gauge indicate zero.

4   Detach the regulator from the cylinder and attach it to the new cylinder.
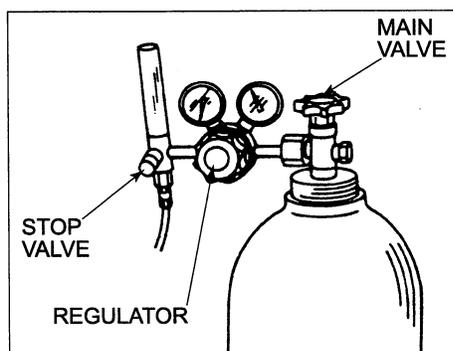
GAS REQUIREMENT

Composition: 5±0.25% CO_2, 55±2.75% N_2, 40±2.00% He
Purity: Over 99.99%
Water content: Below 5 ppm
Hydrocarbon content: Below 1 ppm

5   Keep away from the faces of the pressure gauges and open the main valve.

6   Confirm that the primary pressure gauge is showing a sufficient pressure.

7   Apply soap-suds to the connection of the cylinder and the regulator and confirm that there is no leakage from the connection.

8   Turn the regulator knob to make the secondary pressure gauge indicate 0.15 to 0.2 MPa (1.5 to 2 kgf/cm²).

9   Close the main valve.

Gas blower oil

Change the oil in the laser oscillator gas blower in the following manner:

> ⚠ **WARNING** ● **If the gas blower tank is overfilled, the gas blower may be damaged.**

1 Turn off the shop circuit breaker switch.

2 Wait at least for 5 minutes after the gas blower has stopped.

3 Remove socket head bolts from the side covers and detach the covers — they are on the left side viewed with the oscillator circuit breaker switch in front.

4 Remove the filler bolt together with its O-ring using a 17 mm-size wrench, place a pan and the drain tube in the pan, open the drain cock to drain the oil, and then close the cock after the oil is drained completely.

   NOTE

   ● Dispose of the used oil as specified by the manufacturer and by the applicable government regulations in your country.

5 Fill the specified oil (FANUC A04B-0800-K326) from the filler up to a level between the MAX and MIN lines on the sight gauge.   The tank has a capacity of 150 ml.

6 Clean the filler and its bolt and O-ring by using a dry cloth.

   NOTICE

   ● Inspect the O-ring of the filler bolt and change it if it is deteriorated.

7 Correctly attach the O-ring to the filler bolt, install and tighten the bolt, and then replace and clamp the side covers.
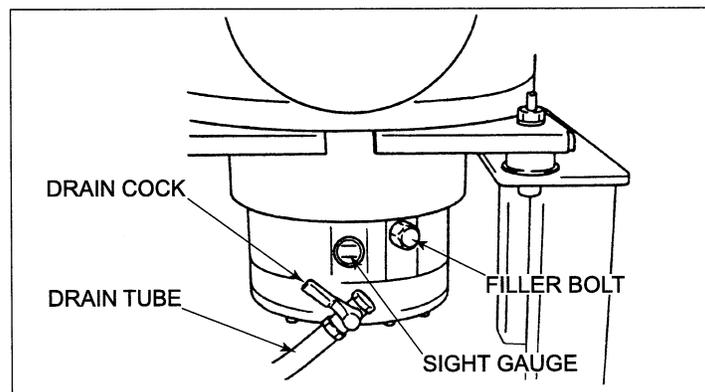
Vacuum pump oil

Change the oil in the laser oscillator vacuum pump and clean the inside of the pump in the following manner:

1   Turn off the shop circuit breaker switch.

2   Wait at least for 5 minutes after the vacuum pump has stopped.

3   Remove socket head bolts from the side covers and detach the covers — they are on the left side viewed with the oscillator circuit breaker switch in front.

4   Remove the filler cap, place a pan and the drain tube in the pan, open the drain cock to drain the oil, and then close the cock after the oil is drained completely.

> **NOTE**
>
> ● Dispose of the used oil as specified by the manufacturer and by the applicable government regulations in your country.

5   Fill the specified oil (FANUC A98L-0040-0093/1.0L6) from the filler up to a level slightly below the MAX line on the sight gauge.   The tank has a capacity of 1.8 liters.

6   Replace the filler cap and the side covers and clamp the covers.

> **NOTICE**
>
> ● Inspect the O-ring of the filler cap and change it if it is deteriorated.

7   Turn on the power and prepare the machine for laser cutting.

8   Turn the LASER keyswitch to ON, wait for 3 minutes, and then return the keyswitch to OFF.

9   Turn off the power and repeat Steps 1 to 6 to drain the oil and fill the new oil again.
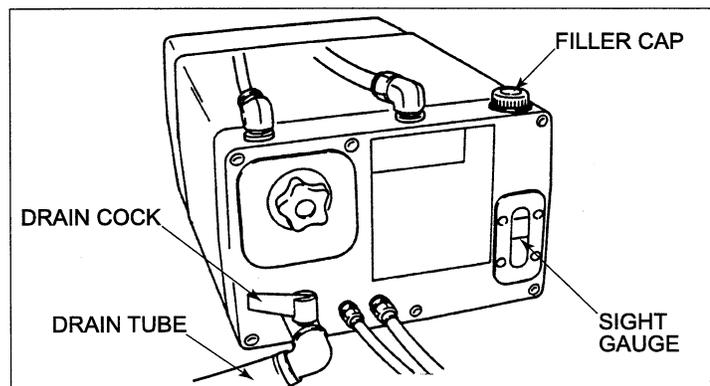
Air system air filter

Inspect the air filter in the air system and change it, if necessary, in the following manner:

1 Stop the air supply to the machine.

2 Turn off the shop circuit breaker switch.

3 Push down the knob in the front of the air filter cover and turn the cover counterclockwise to remove it.

4 Remove the filter clamp screw and then the filter.

5 Inspect the filter and change it if necessary.

6 Set and clamp the filter.

7 Replace the cover and turn clockwise until the knob in the front of the cover comes up.

CNC memory backup cells

Change the CNC memory backup cells inside the CNC control unit in the following manner once every 12 months or whenever an alarm for a low cell voltage has been caused:

1   Prepare two cells (side D).

2   Turn on the CNC control unit.

3   Remove the cover of the cell case on the electrical control unit.

4   Change the dead cells for new ones.
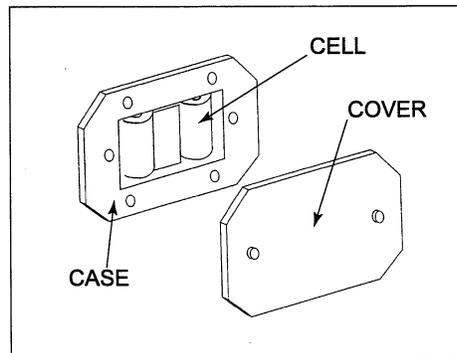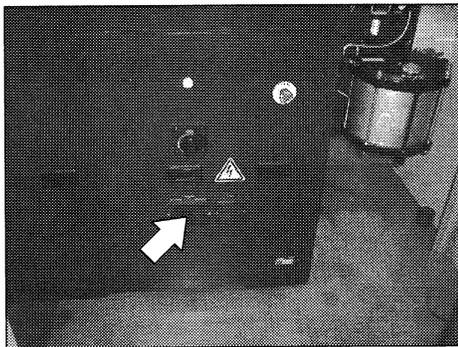
5   Replace the cover.

Nozzle & Z-axis tracking sensor

Change the nozzle and Z-axis tracking sensor in the following manner:

1   Move the Y-axis to the end opposite to the origin, and lower the Z-axis to a position about 150 mm above the machine table in the MANUAL mode.

2   Turn off the shop circuit breaker switch.

3   Disconnect the Z-axis tracking sensor cable from the junction board.

4   Pull out the nozzle unit lock bar, turn the unit counterclockwise (viewed from the bottom), and remove the unit.

5   Turn the nozzle counterclockwise (viewed from the bottom) and remove it from the Z-axis tracking sensor.

6   Loosen the adjustment screws and remove the cone from the nozzle unit.

7   Install the new sensor and nozzle by reversing the above steps.

   _____
   NOTICE
   _____

   ● Be sure to install the O-ring between the sensor and nozzle holder; otherwise, the assist gas may leak.

8   Replace the nozzle unit by turning it clockwise and then push in the lock bar.

9   Connect the Z-axis tracking sensor cable to the junction board.

B-axis coordinate value backup cells (option)

If the machine is equipped with the optional focal point CNC control, change the B-axis coordinate value backup cells inside the electrical control unit as described below every year.   Change the cells also when they have run down to produce a low cell voltage alarm (APC alarm 306, 307, or 308).

NOTICE

● Change the cells with the CNC control unit turned on.   If the cells are removed with the CNC control unit turned off, the B-axis coordinate values will be lost from the memory.

1   Prepare four alkaline-manganese cells (size D).

2   Turn on the CNC control unit.

3   Remove the cover of the cell case on the electrical control unit.

4   Change the dead cells for new ones.

5   Replace the cover.
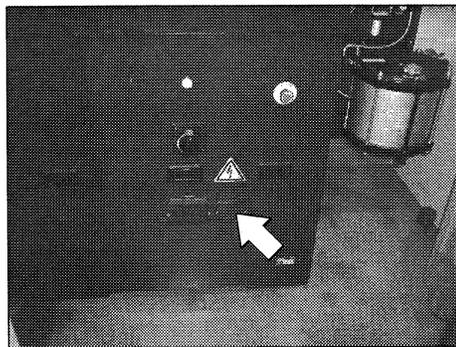
Appendix A
Processing Condition Files

PROCESSING CONDITION FILES

Processing condition files where normal cutting conditions, piercing conditions, and edge and approach cutting conditions are preset are registered beforehand in the CNC.

One processing condition file can set 10 normal cutting conditions (9 for cutting and 1 for scribing), 3 piercing conditions, and 5 edge-and-approach cutting conditions.   (See the note below.)   A maximum of 90 processing condition files can be registered, including those already registered.   For registering a new processing condition file and setting normal cutting, piercing or edge-and-approach cutting conditions, see "Executor displays" in Part II Displays.

NOTE

● When a pre-registered processing condition file has less than 9 normal cutting conditions, the condition with the highest cutting feed rate is set for the numbers for the other conditions.   When setting new conditions, change unnecessary conditions, or register a new processing condition file and set necessary conditions in the file.

Names of processing condition files

The pre-registered processing condition files are named according to the material name (JIS standard), thickness (in millimeters), and cutting method of the worksheet for which the cutting conditions are set.
When the material name ends in a number, it is connected by a hyphen to the thickness.

SPC	Mild steel SPCC
SPH	Mild steel SPHC
SS400	Mild steel SS400
E-SPC	EasyCut (EZ-cut) of mild steel SPCC
SUS	Ordinary cut (oxygen cut) of stainless steel SUS304-2B
A-SUS	AirCut of stainless steel SUS304-2B
C-SUS	CleanCut of stainless steel SUS304-2B
E-SUS	EasyCut (EZ-cut) of stainless steel SUS304-2B
A1050	Pure aluminum A1050
A5052	Aluminum alloy A5052
SECC	Electrogalvanized steel SECC with zinc coating weight of 10 g/m² per side
E-SECC	EasyCut (EZ-cut) of electrogalvanized steel SECC with zinc coating weight of 10 g/m² per side

Programming

Cutting program commands are used to specify a processing condition file required for laser cutting and one cutting condition set in the file, as shown in the example given below.

NOTE

● Mount a lens on the laser head according to the data set for "Head" in the processing condition file.   Mount a lens with the focal length of 7.5" when "1" is selected for "Head" and a lens with the focal length of 5" when "2" is selected.

● Mount a nozzle unit on the laser head according to the data set for "Mtrl info" and "Head" in the processing condition file.   Mount a nozzle unit with the nozzle diameter of 3 mm when "Thick" and "1" are selected for "Mtrl info" and "Head," respectively, and a nozzle unit with the nozzle diameter of 2 mm in any other case.

● Adjust the lens focal point according to the data set for "Focal" in the processing condition file.   This adjustment need not be made when the machine is equipped with an optional focal point CNC control.

Example: O100;
M102(C-SUS1.0); ········· ①
G90 G92 X1270 Y1270;
G00 X20 Y20;
M100;
E01; ···················· ②
G01 Y10;
:
:
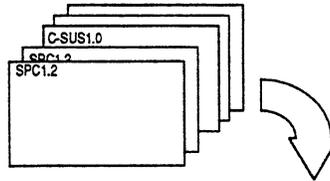
① The processing condition file C-SUS1.0 is selected by "M102 (C-SUS1.0)."

② No. 1 cutting condition is selected by "E01."

Cutting conditions

C-SUS1.0			Pirc No.	1 0 1
Cut No.	Feed rate	Pwr.	······ Edge data	······
1	**	**	**	2 0 1
2	**	**	**	* * *
3	**	**	**	* * *
4	**	**	**	* * *
5	**	**	**	* * *
:				

Since 101 is set for "Pirc No.," No. 101 piercing condition is selected.

Piercing conditions

C-SUS1.0			
Pirc No.	Pwr.	(Initial) Freq.	(Increm) duty
1 0 1	**	**	***
1 0 2	**	**	***
1 0 3	**	**	***

Edge cutting conditions

C-SUS1.0				
Edge No.	Pirc Pwr.	Pirc Freq.	Pirc duty	··
2 0 1	**	**	***	
2 0 2	**	**	***	
2 0 3	**	**	***	
2 0 4	**	**	***	
2 0 5	**	**	***	

Since 201 is set for "Edge data," No. 201 edge cutting condition is selected.

APPROACH AND EDGE CUTTING FUNCTIONS

The approach and edge cutting functions judge whether or not the portion to be cut is an approach or edge cut portion from the setup data of the CNC, and control the laser beam so that the approach or edge cut can be made under optimum conditions.

Approach cutting function

The approach cutting function controls the laser beam so that a successful approach cut can be made after the completion of piercing. This function is effective in preventing a problem when cutting heavy-gage mild steel or cutting any type of worksheet by the Aluminum-cut, Clean-cut*, Air-cut, or EZ-cut* method.

*Clean-cut and EZ-cut accessories are optional.
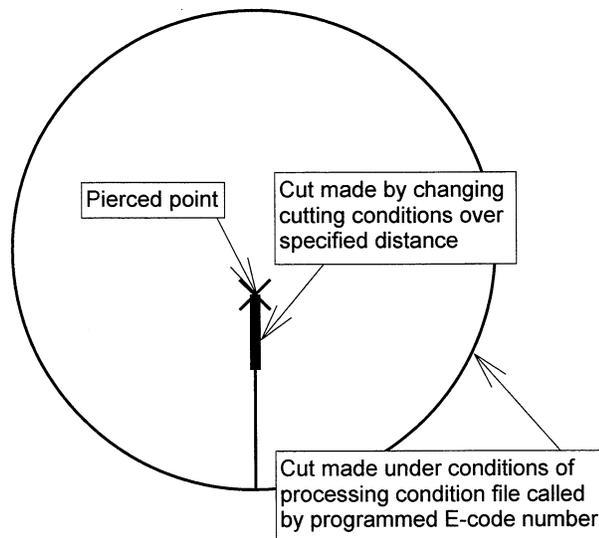
When approach cutting is performed, normal cutting conditions are changed to approach cutting conditions over the specified distance from the pierced point according to the approach cutting conditions in the processing condition file.   For more stable cutting, set a lower approach cutting feed rate.

Edge cutting function

The edge cutting function prevents cutting problems like edge meltdown. This function is effective in cutting mild steel and other materials whose edge is likely to melt down.

The edge cutting function need not be used when the edge is to be cut by a method that prevents the edge from melting down, such as Clean-cut*, Air-cut, or EZ-cut* (but can be used without any problem).

*Clean-cut and EZ-cut accessories are optional.


```
                              Pierced point

                              Piercing motion        Slowdown at
                              at edge                exit of edge
```
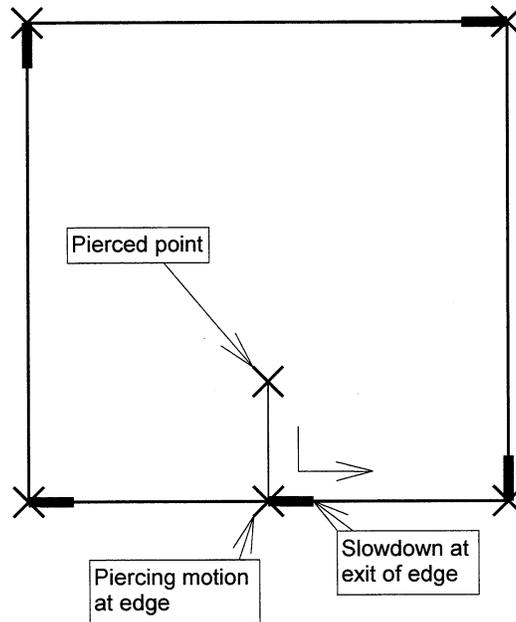
When edge cutting is performed, the laser beam makes a piercing motion at the edge according to the edge cutting conditions in the processing condition file, and the normal cutting conditions are changed to the edge cutting conditions over the specified distance.

The maximum angle for edge control is set at "Work angle" among the edge cutting conditions.   When the edge angle calculated in the CNC is smaller than the preset value of "Work angle", edge cutting control is automatically performed.

The edge angle automatically judged by the CNC is not the edge angle commanded in the program, but is the edge angle commanded in the program and compensated for the cutting path.   The CNC calculates the edge angle by a different method, depending on whether the cutting path is compensated for at the left or right side of the laser beam in the cutting direction.

Left-side compensation

When the cutting path is compensated for at the left side of the laser beam in the cutting direction, the edge angle becomes as shown below. The edge angle commanded in the program becomes the same as that calculated in the CNC.

- ◁ — — — : Cutting direction
- — — — — — : Cutting path under normal cutting conditions
- ——————— : Cutting path under edge cutting conditions
- ▬▬▬▬▬ : Cutting program shape
- ▲ : Edge angle judged (after compensation)

Laser beam

Start point End point

Edge angle judged in left-side compensation
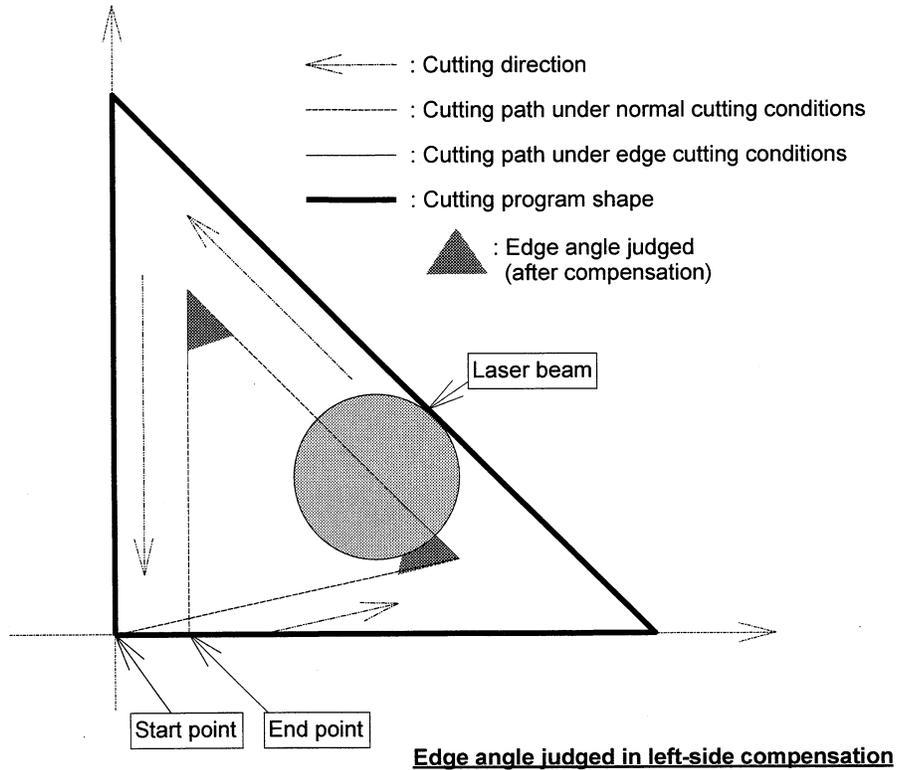
Right-side compensation

When the cutting path is compensated for at the right side of the laser beam in the cutting direction, the edge angle commanded in the program becomes different from that calculated in the CNC. When right-side compensation is commanded, the CNC forms minute blocks at the edge as shown below.

A-6

Minute block formed by compensation

⊰----- : Cutting direction

------- : Cutting path under normal cutting conditions

——— : Cutting path under edge cutting conditions

▬▬▬ : Cutting program shape

◣ : Edge angle judged (after compensation)

Laser beam

Minute block formed by compensation

End point   Start point
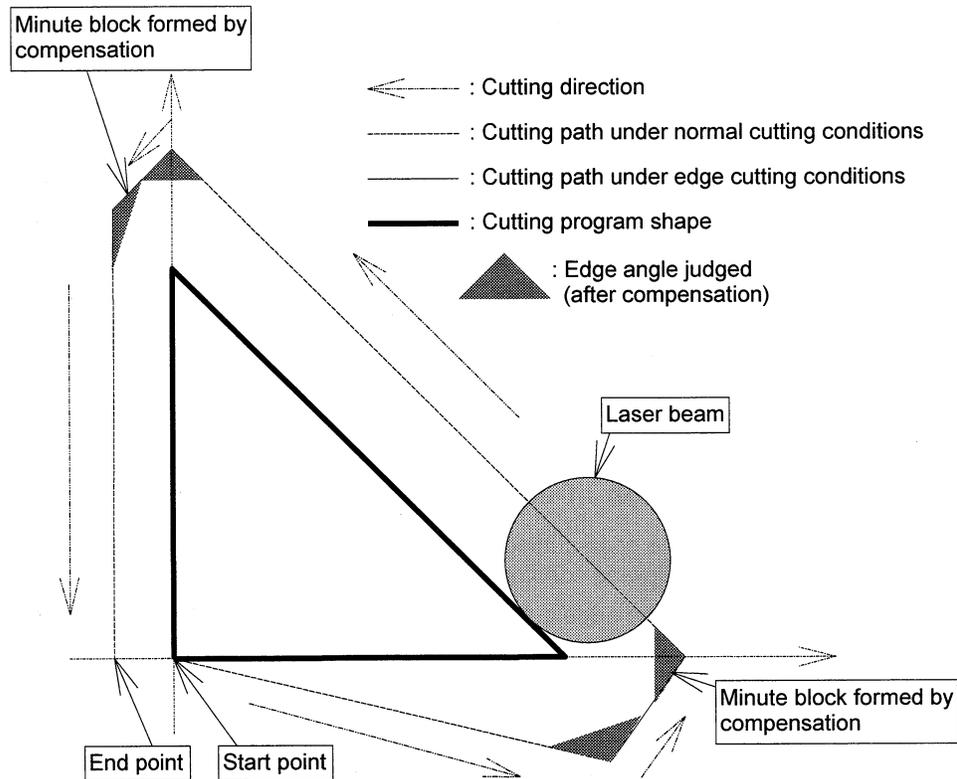
Edge angle judged in right-side compensation

Edge cut processing becomes effective for the data obtained after the cutting path compensation. When a minute block is formed at the edge, the CNC assumes the angle of the minute block as the edge angle and judges the motion of the laser beam accordingly. The minute block is formed during calculation in the CNC and cannot be confirmed in the program. The edge angle in the minute block formed varies with the shape of the cut to be made and is difficult to calculate.

A large standard value of 150° is set at "Work angle" among the edge cutting conditions, so that edge cutting can be performed in the right-side compensation even when minute blocks are formed. Fully consider this point when changing the preset value.

Edge cutting is not performed when "Work angle" is 0°. Edge cutting is performed for all edges and tangents when "Work angle" is 180°. Edge cutting is performed for all edges but tangents when "Work angle" is 179°.

NOTE

● "Work angle" need not be set in the approach cutting conditions. Any value set at "Work angle" is ignored during approach cutting.

Using approach and edge cutting functions

When numbers 201 to 205 are entered at "Appr. data" and "Edge data" on the CUTTING CONDITION display for the processing condition file called by the program, the CNC can make approach and edge cuts under automatic control.

The necessary approach or edge cutting conditions must be preset at the corresponding numbers. If any number where approach or edge cutting conditions are not preset is specified, an alarm occurs during approach or edge cutting or the cutting is performed under the approach or edge cutting conditions selected last. The approach and edge cutting conditions are set on the EDGE CUTTING CONDITION display for the processing condition file.

Constraint on creation of edge cutting program

The edge cutting function is controlled by the CNC and imposes the following constraint in the program:

- The edge cutting function does not operate if G00 is commanded for the edge.

NOTE

● When assigning the laser beam cutting path during the creation of a program with the automatic programming unit, turn off the output of G00. When the program is created under this condition, G00; is not output in the program.

"HS: HIGH SPEED" CUTTING CONDITION FILE

We would like to introduce how to execute high speed laser cutting when selecting "HS" on the "cutting condition file".

Assist gas may not distribute properly, cutting head may exceed –Z OT, or the nozzle may contact with the material if above utilization is inappropriate.

WHAT IS HIGH SPEED CUTTING ?

"High speed cutting" is valid when "HS" is selected on "Mtrl info" of the cutting condition file.

"High speed cutting", compared to "standard cutting", will not only eliminate "Z-axis retreating" time during axes fast feed but also simplifies the internal sequence of M103 and M104, unless you specifically designate the command.

(The sequence will eliminate unnecessary M-codes, G-codes, and diversions.)

<Unnecessary diversions>

1. SPECIAL SEQUENCE FOR CLEAN-CUT AND AL-CUT
2. "CW BLOW" SEQUNECE AFTER PIERCING WHEN "THICK" IS SELECTED
3. M-CODE AND "CW BLOW" SEQUENCE ON COOLING CUT
4. PRE-FLOW TIMER ON PIERCING, AND CUTTING ASSIST GAS
5. ASSIST GAS FLOW HEIGHT CHECK SEQUENCE

<Unnecessary M-codes and G-codes>

1. CODE FOR SENSOR ON/OFF
2. CODES RELATED TO ASSIST GAS
3. CODES RELATED TO MECHANICAL SHUTTER.

(only available on trigger oscillators)

As a result, the cycle time will reduce from 0.4 to 0.2 second in general by simplifying these M103/M104 internal sequences.

ASSIST GAS SET UP AND PRECAUTION

HS "Piercing assist gas command" inside M103 will be distributed on the following two occasions.

1. The very first M103

2. M103 which follows M104M_(eg:M108) or M104Z_ command

.NB) M103 will not distribute pierce command which follows only M104.

"M104 M_" and "M104 Z_" will reserve "assist gas command" in advance selecting the gas kind during axes fast feed and elliminate M103's gas selection time delay in order to meet high speed cutting.

"Piercing assist gas" may not be distributed if you insert M180 or M00 individually in between M104 and M103 shown as below.

Ensure to insert M108 or M00 along with M104 on the same block such as "M104 M180" to succeed the sequence.

```
    :
M104;
M180;
G00 X__ Y__;
M103;
    :
```

$\longrightarrow$

```
    :
M104 M180;
G00 X__ Y__;
M103;
    :
```
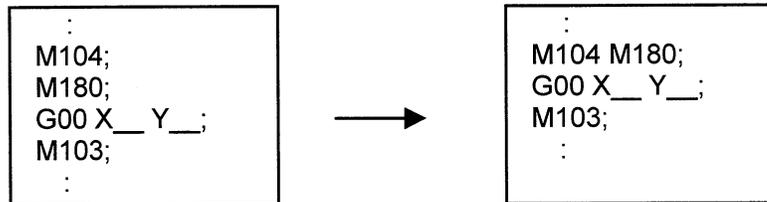
CAPACITANCE SENSOR SET UP AND PRECAUTION

Z axis will cancel the capacitance sensing and physically retreat while axes fast feed under standard cutting.

However, Z axis will continue capacitance sensing and does not physically retreat on HS (high speed) mode to eliminate the delay of the Z-axis movement and sensing ON/OFF sequence.

Subsequently, capacitance sensor will help to maintain consistant gap between nozzle and worksheet while axes are fast feeding with the head down.

Z axis may catch –Z OT if there is a large hole along the axes feeding path while capacitance sensior is activating.

Please follow the instuctions as below to overcome with this problem.

Retreat Z axis in advance by inserting M104Z_.

```
  :
M104;
G00 X__ Y__;
M103;
  :
```

➡️

```
  :
M104 Z__;
G00 X__ Y__;
M103;
  :
```
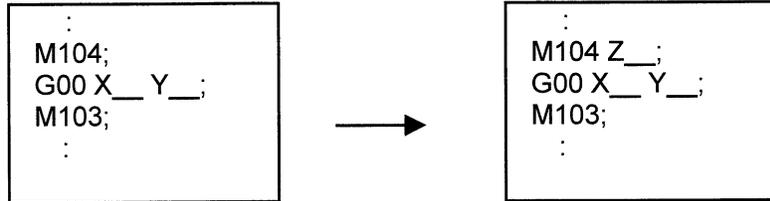
Command G33 (Z capacitance mode cancel) after M104 and feed the axes with G00. Insert G32 (Z capacitance mode) after reaching to the destination.

```
  :
M104;
G00 X__ Y__;
M103;
  :
```

➡️

```
  :
M104;
G33;
G00 X__ Y__;
G32;
M103;
  :
```
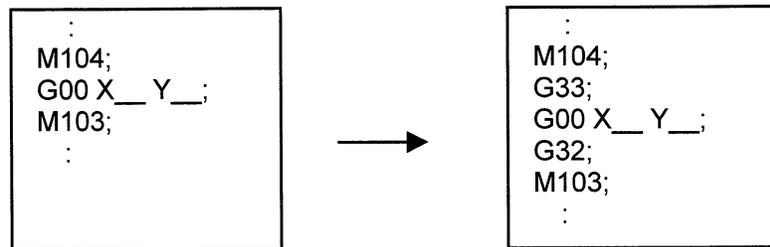
Z axis sensor may malfunction if you command M108 or M00 indivisually in between M104 and M103.

Always command together with M104 such as "M104 M_".

```
  :
M104;
M180;
G00 X__ Y__;
M103;
  :
```

➡️

```
  :
M104 M180;
G00 X__ Y__;
M103;
  :
```
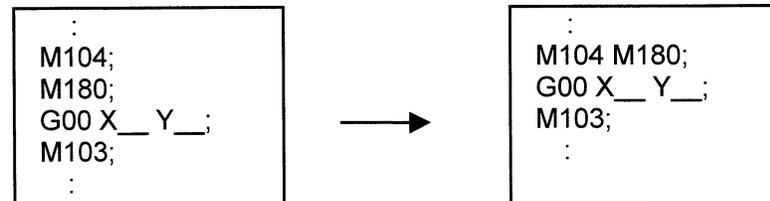
Appendix B
Safety
Data Sheets

Oil
   Shell Alvania Grease 2
   Shell Tellus Oil C32
   Royal Aeroshell Fluid 12
   Matsumura Neovac SA-H
Lens
   Zinc Selenide
Gas
   Laser Gas Nitrogen
   Laser Gas Carbon Dioxide
   Laser Gas Helium

SAFETY DATA SHEET   SHELL ALVANIA GREASE 2

1. NAME

PRODUCT: SHELL ALVANIA GREASE 2
CHEMICAL NAME: LUBRICATING GREASE

2. PRODUCT/INGREDIENT

	percent	toxicity
SHELL ALVANIA GREASE 2	100	not available
Solvent Refined petroleum hydrocarbons	balance	oil mist, TWA ACGIH/OSHA 5 mg/m^3 estimated oral $LD_{50} > 5$ g/kg (rat) estimated dermal $LD_{50} > 2$ g/kg
Litium hydroxystearate	ca. 9	
Aromatic Amine	1	oral LD_{50} 1.6 g/kg (rat)
Sodium Nitrite	0.8	oral LD_{50} 180 mg/kg (rat)

Based upon data available to Showa Shell this product is not hazardous under OSHA HAZARD COMMUNICATION (29 CFR 1910, 1200)

3. HEALTH INFORMATION

ROUTE OF ENTRY:

Eye contact: May be irritating to the eyes.
Skin contact: Prolonged or repeated skin contact may cause skin irritation.

Inhalation: No specific information.

Ingestion: No specific information.

SIGNS AND SYMPTOMS:
Irritation as above.

AGGRAVATED MEDICAL CONDITIONS:
Pre-existing skin disorder may be aggravated by exposure to this product.

OTHER HEALTH EFFECTS:
This specific product has not been tested in long-term chronic exposure tests. The handling procedures and safety precautions in this MSDS should be followed to minimize employee' exposure.

4. OCCUPATIONAL EXPOSURE LIMITS

OSHA		ACGIH		OTHER
PEL/TWA	PEL/CEILING	TLV/TWA	TLV/STEL	

No OSHA/PEL or ACGIH/TLV has been established.

5. EMERGENCY AND FIRST AID PROCEDURES

EYE CONTACT:

Flush with water for 15 minutes while holding eyelids open. Get medical attention.

SKIN CONTACT:

Remove contaminated clothing and wipe excess off. Wash with soap and water or waterless hand cleaner followed by soap and water. Do not re-use clothing until thoroughly cleaned. If irritation persists, get medical attention promptly to prevent serious damage: do not wait for symptoms to develop.

INHALATION:

Remove victim to fresh air and provide oxygen if breathing is difficult. Get medical attention.

INGESTION: Get medical attention.

6. SUPPLEMENTAL INFORMATION

Non identified.

7. PHYSICAL DATA

Boiling Point °C: NA

Specific Gravity: NA

Vapour Pressure: NA

Vapour Density: NA

Appearance & Odour: amber color, slight odour grease

Solubility in water: insoluble

Melting Point: NA

8. FIRE AND EXPLOSION HAZARDS

Flash Point (COC) °C: 210 for base oil

Flammable Limit % vol in air: LEL:NA ; UEL:NA

EXTINGUISHING MEDIA:

Use water fog, dry chemical or CO_2. Do not use direct stream of water. Product will float and can be reignited on surface water.

SPECIAL FIRE FIGHTING PROCEDURES AND PRECAUTIONS:

Do not enter confined fire space without proper protective equipment including a NIOSH approved self-contained breathing apparatus. Cool fire exposed container, surrounding equipment and structures with water.

9. REACTIVITY

Stability: Stable

Hazardous polymerization: Will not occur

Conditions and Materials to avoid: strong oxidizers

Hazardous decomposition product:

NOx, SOx, COx, and other unidentified oxygenates can be formed during combustion.

10. EMPLOYEE PROTECTION

RESPIRATORY PROTECTION:

A NIOSH approved respiratory protection equipment should be used when vapour or mist concentration exceed applicable standards.

PROTECTIVE CLOTHING:

Use oil resistant gloves and other clothing as minimize skin contact.

11. ENVIRONMENTAL PROTECTION

SPILL OR LEAK PROCEDURE:

Scoop up excess grease. Clean area with appropriate cleaner.

WASTE DISPOSAL:

Dispose of in an appropriate disposal facility in compliance with appropriate regulations.

12. SPECIAL PRECAUTIONS

Store in a cool, dry place with adequate ventilation. Keep away from open flames and high temperature. Minimize skin contact. Wash with soap and water before eating, drinking, smoking or using toilet facilities.

Launder contaminated clothing before using. Discard leather goods if they cannot be decontaminated. Wash before eating or smoking. Observe good personal hygiene.

13. OTHER REGULATORY CONTROL

All components of this product are listed on the EPA/TSCA inventory of chemical substances.

The information contained herein is based on the data available to Showa Shell and is believed to be correct. However, Showa Shell makes no warranty, expressed or implied regarding the accuracy of these data or the results to be obtained from the use thereof. Showa Shell assumes no responsibility for injury from the use of the product described herein.

DATE PREPARED: 8th June, 1993

SAFETY DATA SHEET   SHELL TELLUS OIL C32

1. NAME

PRODUCT: Tellus Oil C32
CHEMICAL NAME: Petroleum Hydrocarbons

2. PRODUCT/INGREDIENT

	percent	toxicity
Tellus Oil C32	100	not available
Severely refined petroleum hydrocarbons	ca.99	oil mist, TWA ACGIH/OSHA 5 mg/m^3 oral LD_{50} >15 g/kg(rat) estimated

Based upon data available to Showa Shell this product is not considered to be carcinogenic under OSHA HAZARD COMMUNICATION STANDARD (29 CFR 1910, 1200) (IARC MONOGRAPH 33).

3. HEALTH INFORMATION

ROUTE OF ENTRY:

Eye contact: Expected, at worst, to be minimally irritating to the skin.

Skin contact: Prolonged or repeated skin contact may cause skin irritation.

Inhalation: No specific information.

Ingestion: No specific information.

SIGNS AND SYMPTOMS:
Irritation as above.

AGGRAVATED MEDICAL CONDITIONS:
Pre-existing skin disorder may be aggravated by exposure to this product.

OTHER HEALTH EFFECTS:
This specific product has not been tested in long-term chromic exposure tests.
Lubricating oils are generally considered to be a low order of acute toxicity to humans and experimental animals. However, the handling procedures and safety precautions in this MSDS should be followed to minimize employee' exposure.

4. OCCUPATIONAL EXPOSURE LIMITS

OSHA		ACGIH		OTHER
PEL/TWA	PEL/CEILING	TLV/TWA	TLV/STEL ·	
		5mg/m³	---	
	(OIL MIST, mineral	Severely refined)		

5. EMERGENCY AND FIRST AID PROCEDURES

EYE CONTACT:

Flush with water for 15 minutes while holding eyelids open. Get medical attention.

SKIN CONTACT:

Remove contaminated clothing and wipe excess off. Wash with soap and water or waterless hand cleaner followed by soap and water. Do not re-use clothing until thoroughly cleaned. If irritation persists, get medical attention promptly to prevent serious damage: do not wait for symptoms to develop.

INHALATION:

Remove victim to fresh air and provide oxygen if breathing is difficult. Get medical attention.

INGESTION: Get medical attention.

6. SUPPLEMENTAL INFORMATION

Non identified.

7. PHYSICAL DATA

Boiling Point °C : NA
Specific Gravity: ca. 0.87 at 15/4 °C
% Volatile by wt: NA
Vapour Density: >1 (air = 1)
Appearance: pale yellow liquid
Solubility in water: negligible
Odour: characteristic odour

8. FIRE AND EXPLOSION HAZARDS

Flash Point (COC) °C: 226

Flammable Limit % vol in air: NA

EXTINGUISHING MEDIA: Use water fog, dry chemical or CO_2.

SPECIAL FIRE FIGHTING PROCEDURES AND PRECAUTIONS:

Do not enter confined fire space without proper protective equipment including a NIOSH approved self-contained breathing apparatus. Cool fire exposed container, surrounding equipment and structures with water.

9. REACTIVITY

Stability: Stable

Hazardous polymerization: Will not occur

Conditions and Materials to avoid: Strong oxidizers

Hazardous decomposition product:

NOx, SOx, CO, and other unidentified oxygenates can be formed during combustion.

10. EMPLOYEE PROTECTION

RESPIRATORY PROTECTION:

A NIOSH approved respiratory protection equipment should be used when vapour or mist concentration exceed applicable standards.

PROTECTIVE CLOTHING:

Use oil resistant gloves and other clothing as minimize skin contact.

VENTILATION: Mechanical equipment.

EYE PROTECTION:

Normal industrial eye protection equipment should be employed.

11. ENVIRONMENTAL PROTECTION

SPILL OR LEAK PROCEDURE:

Prevent entry into sewers and waterways. Pick up free liquid for disposal. Absorb small amount on inert material for disposal.

WASTE DISPOSAL:

Dispose of in an appropriate disposal facility in compliance with appropriate regulations.

12. SPECIAL PRECAUTIONS

Store in a cool, dry place with adequate ventilation. Keep away from open flames and high temperature. Minimize skin contact. Wash with soap and water before eating, drinking, smoking or using toilet facilities.

Launder contaminated clothing before using. Discard leather goods if they cannot be decontaminated. Wash before eating or smoking. Observe good personal hygiene.

13. OTHER REGULATORY

All components of this product are listed on the EPA/TSCA inventory of chemical substances.

The information contained herein is based on the data available to Showa Shell and is believed to be correct. However, Showa Shell makes no warranty, expressed or implied regarding the accuracy of these data or the results to be obtained from the use thereof. Showa Shell assumes no responsibility for injury from the use of the product described herein.

DATE PREPARED: 22nd August, 1994

SAFETY DATA SHEET   ROYAL AEROSHELL FLUID 12
(FANUC A04B-0800-K326)

SECTION I NAME

Product   Aeroshell Fluid 12

Chemical name   Mixture (See Section II-A)

Chemical family   Synthetic Ester

SECTION II-A   PRODUCT/INGREDIENT

NO.	COMPOSITION	PERCENT
P	Aeroshell Fluid 12	100
1	Synthetic Ester	95-97
2	Barium Dinonylnaphalene Sulfonate	2-4
3	Sutylated Hydroxy Toluene	1.0-1.5

SECTION II-B ACUTE TOXICITY DATA

NO. ACUTE ORAL LD50   ACUTE DERMAL LD50   ACUTE INHALATION LC50

P   Not available

Based upon data available to Royal, component 1 in this product is not hazardous under OSHA hazard communication.

SECTION III HEALTH INFORMATION

The health effects noted below are consistent with requirements under the OSHA hazard communication standard.

EYE CONTACT

Based on presence of component 2 and 3, product is irritating to the eyes.

SKIN CONTACT

Prolonged or repeated contact may cause various skin disorders such as dermatitis, folliculitis or oil acne.

INHALATION

Inhalation of vapors (generated at high temperatures only) or oil mist may be mildly irritating to the nose, throat and respiratory tract.

INGESTION

Ingestion of product may result in vomiting: Aspiration (breathing) of vomitus into the lungs must be avoided as even small quantities may result in aspiration pneumonitis.

SIGNS AND SYMPTOMS

Irritation as noted above. Aspiration pneumonitis may be evidenced by coughing, labored breathing and cyanosis (bluish skin); in severe cases death may occur.

AGGRAVATED MEDICAL CONDITIONS

Preexisting eye, skin and respiratory disorders may be aggravated by exposure to this product.

OTHER HEALTH EFFECTS

This product does not contain any carcinogen as identified by IARC, NTP or OSHA.

SECTION IV OCCUPATIONAL EXPOSURE LIMITS

NO.	PEL/TWA ^{OSHA} PEL/CEILING	TLV/TWA ^{ACGIH} TLV/STEL	OTHER
P	Not established*		
2	0.5 mg/m^3**	0.5 mg/m^3**	250 IDLH

*Royal recommends the PEL and TLV for mineral oil mist 5 mg/m^3 TWA.

**Barium

SECTION V EMERGENCY AND FIRST AID PROCEDURES

EYE CONTACT

Immediately flush eyes with plenty of water for at least 15 minutes while holding eyelids open. Get medical attention.

SKIN CONTACT

Remove contaminated clothing/shoes and wipe excess from skin. Flush skin with water. Follow by washing with soap and water. If irritation occurs, get medical attention. Do not reuse clothing until cleaned.

INHALATION

Remove victim to fresh air and provide oxygen if breathing is difficult. Get medical attention.

INGESTION

Do not induce vomiting. If vomiting occurs spontaneously, keep head below hips to prevent aspiration of liquid into the lungs. Get medical attention.

SECTION VI SUPPLEMENTAL INFORMATION

None identified.

SECTION VII PHYSICAL DATA

Boiling point (deg F) : Not available

Specific gravity (H_2O = 1) : 0.92

Vapor pressure (mmHg) : Not available

Melting point (deg F) : Not available

Solubility (in water) : Negligible

Vapor density (air = 1) : Not available

Evaporation rate (N-butyl acetate = 1) : Not available

Appearance and odor : Light amber oil, blight odor

SECTION VIII FIRE AND EXPLOSION HAZARDS

Flash point and method: 440 deg, F COC

Flammable limits / % volume in air: N/AV (lower),   N/AV (upper)

EXTINGUISHING MEDIA

Use water fog, foam, dry chemical or CO_2. Do not use a direct
stream of water. Product will float and can be reignited on surface of
water.

SPECIAL FIRE FIGHTING PROCEDURES AND PRECAUTIONS

Material will not burn unless preheated. Do not enter confined fire
space without full bunker gear (helmet with face shield, bunker coats,
gloves and rubber boots), including a positive pressure NIOSH
approved self-contained breathing apparatus. Cool fire exposed
containers with water.

SECTION IX REACTIVITY

Stability: Stable

Hazardous polymerization: Will not occur

CONDITIONS AND MATERIALS TO AVOID

Avoid heat, flame and contact with strong oxidizing agents.

HAZARDOUS DECOMPOSITION PRODUCTS

Thermal decomposition products are highly dependent on the
combustion conditions. A complex mixture of airborne solid, liquid,
particulates and gases will evolve when this material undergoes
pyrolysis or combustion, carbon monoxide and other unidentified
organic compounds may be formed upon combustion.

SECTION X EMPLOYEE PROTECTION

RESPIRATORY PROTECTION

Use a NIOSH-approved respirator as required to prevent overexposure. In accord with 25 CFR 1810.134, use either an atmosphere-supplying respirator or an air-purifying respirator for organic vapors and particulates.

PROTECTIVE CLOTHING

Avoid contact with eyes. Wear chemical goggles if there is likelihood of contact with eyes. Avoid prolonged or repeated contact with skin. Wear gloves and other clothing as required to minimize contact.

SECTION XI ENVIRONMENTAL PROTECTION

SPILL OR LEAK PROCEDURES

May burn although not readily ignitable. Use cautions judgment when cleaning up large spills. ***Large spills*** Wear respirator and protective clothing as appropriate. Shut off source of leak if safe to do so, dike and contain. Remove with vacuum trucks or pump to storage/salvage vessels. Soak up residue with an absorbent such as clay, sand or other suitable material; dispose of properly, flush area with water to remove trace residue. ***Small spills*** Take up with an absorbent material and dispose of properly.

WASTE DISPOSAL

Dispose of as hazardous waste DOO5 based on barium content. Unless extraction results show less than the EPA limit.

ENVIRONMENTAL HAZARDS

Under EPA-CWA, this product is classified as an oil under section 311. Spills into or leading to surface waters that cause a sheen must be reported to the National Response Center. Under SARA Title III, section 313, this product contains barium compounds.

SECTION XII SPECIAL PRECAUTIONS

Store in a cool, dry place with adequate ventilation. Keep away from open flames and high temperatures.

Wash with soap and water before eating, drinking, smoking or using toilet facilities. Launder contaminated clothing before reuse.

SECTION XIII TRANSPORTATION REQUIREMENTS

Department of transportation classification: Not hazardous by D.D.T. regulations

SECTION XIV OTHER REGULATORY CONTROLS

The components of this product are listed on the EPA/TSOA inventory of chemical substances.

The information contained herein is based on the data available to us and is believed to be correct. However, Royal makes no warranty, expressed or implied regarding the accuracy of these data or the results to be obtained from the use thereof. Royal assumes no responsibility for injury from the use of the product described herein.

DATE PREPARED: 15th April, 1993

SAFETY DATA SHEET MATSUMURA NEOVAC SA-H
(FANUC A98L-0040-0093/1.0L6)

Section I – Name

IDENTITY (As used on Label and List)
 	
  NEOVAC SA-H
 	
Manufacturer's Name
  MATSUMURA OIL RESEARCH CORP.

Section II – Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity ; Common Name (s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
Alkyl diphenyl ether	n/e	n/e	n/e	99
n-Octadecyl-3-(4-hydroxy-3,5-di-tert-butylphenyl) propionate	n/e	n/e	n/e	1

  * Hazardous Components : None present
    n/e = none established

Section III – Physical/Chemical Characteristics

Boiling Point (°C/mmHg)
 	
     180/0.1
	Specific Gravity (H2O = 1)
	
	     0.900 (15/4°C)

Vapor Pressure (mmHg/°C)
 	
     3×10^{-7} / 50
	Pour Point (°C)
	
	     –15.0

Vapor Density (AIR = 1) >1	Evaporation Rate (Butyl Acetate = 1) <1
Solubility in Water Negligible	
Appearance and Odor Light yellow, viscous liquid with slight oily odor	

Section IV – Fire and Explosion Hazard Data

Flash Point (Method Used) (°C)   Flammable Limits
         300 (COC)   LEL : 0.2 %, UEL : 6.0 %

Extinguishing Media
         Dry chemical, CO_2, Foam

Special Fire Fighting Procedures
         None (Same as other mineral lubrication oil)

Unusual Fire and Explosion Hazard
         Handle as a flammable liquid.

Section V – Reactivity Data

Stability	Unstable		Conditions to Avoid
	Stable	x	High temperature exceeding 300°C
Incompatibility (Materials to Avoid)			Strong oxidizing agents
Hazardous Decomposition or Byproducts			CO on incomplete combustion
Hazardous	May Occur		Conditions to Avoid
Polymerization	Will Not Occur	x	High temperature exceeding 300°C

Section VI – Health Hazard Data

Route (s) of Entry :   Inhalation ?   Skin ?   Ingestion ?
                    No   Yes (Slightly)   Unlikely

Health Hazards (Acute and Chronic)
         Acute Oral Toxicity : No information
         Skin irritation : Mildly irritating

Carcinogenicity :   NTP ?   IARC Monographs ?   OSHA Regulated ?
                 No   No   No

Signs and Symptoms of Explosion
         None normally encountered

Medical Conditions Generally Aggravated by Exposure
         Unknown

Emergency and First Aid Procedures
    Skin : Wash with soap and water.
    Eye : Immediately flush eyes with plenty of water for at least 15 minutes.
    Inhalation : None normally encountered
    Ingestion : Use emetic procedures. Contact a physician immediately.

Section VII – Precautions for Safe Handling and Use

Steps to Be Taken in Case Material is Released or Spilled
Remove all sources of ignition. Collect waste in closed drum for disposal.

Waste Disposal Method
Controlled burning.

Precautions to Be Taken in Handling and Storing
Keep away from heat, sparks and flame.

Other Precautions
None

Section VIII – Control Measures

Respiratory Protection (Specify Type)
Not normally required

Ventilation :   Local Exhaust   Special
Not normally required   None

Mechanical (General)   Other
Desirable   None

Protective Gloves   Eye Protection
Rubber   Goggles

Other Protective Clothing or Equipment
None

Work/Hygienic Practices
Wash thoroughly after handling.

DATE PREPARED : 1st November, 1992

SAFETY DATA SHEET

ZINC SELENIDE
(Laser lens and oscillator
inside mirrors)

A. GENERAL INFORMATION

Trade name ZINC SELENIDE	Product code 29652-29686
Chemical name ZINC SELENIDE	Molecular weight 144.34
Formula ZnSe	

B. HAZARDOUS INGREDIENTS			
Material or component	CAS #	WT %	Occupational exposure limits
Selenium Zinc	7782-49-2 7440-66-6	45.3 54.7	TLV-TWA 0.2 mg Se/m^3 5 mg ZnO/m^3 as fume TLV-STEL 10 mg ZnO/m^3 as fume ■ACGIH ■OSHA

C. FIRST AID MEASURES

INGESTION
   If conscious give large quantities of water and induce vomiting, contact a
   physician.

INHALATION
   If dust or fume are inhaled, terminate exposure and move to fresh air immediately,
   contact a physician.

SKIN
   Clothing contaminated with selenium compounds or fumes should be removed and
   the skin washed abundantly with soap or detergent and water. If irritation occurs,
   contact a physician.

EYES
   Flush with plenty of water, contact a physician.

D. HEALTH HAZARDS INFORMATION

PRIMARY ROUTES OF EXPOSURE
Inhalation and oral ingestion.

ACUTE TOXICITY

Inhalation
LC_{50} Inhalation rat : > 5 mg/1 air.
Selenium dioxide (SeO_2) fine dust and fumes are irritating for eyes, nose and throat.
They may cause breathing problems.
Hydrogen Selenide (H_2Se) can cause damage to the lungs.
Hydrogen Selenide (H_2Se) may cause pulmonary oedema.

Ingestion
LD_{50} Oral rat : > 2000 mg/kg B.W.
A high intake of Zinc selenide (ZnSe) may cause gastrointestinal disorders.

Skin
LD_{50} dermal rat : > 2000 mg/kg B.W.
Selenium dioxide (SeO_2) and Hydrogen selenide (H_2Se) affect the skin.

Eyes
Selenium dioxide (SeO_2) and Hydrogen selenide (H_2Se) irritate the eyes.

IRRITATION/SENSITIZATION
Allergic skin reactions could occur.

MEDICAL CONDITIONS POSSIBLY AGGRAVATED
In the worst cases, i.e. by accidents, inflammation of the mucous membranes
especially the respiratory organs may lead to loss of smell, nose bleedings and
catarrhs.

SYMPTOMS OF CHRONIC Se POISONING
- Garlic smell of breath and perspiration
- Marked paleness
- Coated tongue
- Nervousness
- Gastro-intestinal disorders
- Skin disorders.

E. FIRE AND EXPLOSION DATA

Flash point °C	Auto ignition °C temperature	Flammable limits in air (% by vol.)
Not applicable	Not applicable	Not applicable

No risk of fire neither explosion in normal handling conditions.

F. PRECAUTION – PROCEDURES

FIRE EXTINGUISHING AGENTS RECOMMENDED
  Any, preferably dry chemicals, carbon dioxide or foam.

FIRE EXTINGUISHING AGENTS TO AVOID
  None

SPECIAL FIRE FIGHTING PRECAUTIONS
  During fire fighting use an approved respirator for selenium dioxide (SeO_2)

ENGINEERING CONTROLS
  Provide adequate local airexhaust where dust and fumes are formed.

NORMAL HANDLING
  Avoid contact with skin and eyes or breathing the dust.
  Avoid any contact with acids.

STORAGE
  Avoid contact with acids.

SPILL OR LEAK
  The spilled material should be collected without creating dust and used or returned
  for recovery.

PERSONAL HYGIENE
  Avoid ingestion, inhalation and contact with skin.
  Practise good housekeeping and personal hygiene procedures. No eating, drinking
  or smoking in work area. Wash hands thoroughly before eating or smoking. Take
  a shower and change clothes at end of shift. Do not wear contaminated clothing
  home. Do not use compressed air for blowing dust off clothes or equipment. Keep
  workfloors clean by vacuuming. Avoid irritation by other products when handling
  zinc selenide.

GENERAL
  Periodic urinalysis may be helpful.

G. PERSONAL PROTECTIVE EQUIPMENT

RESPIRATORY PROTECTION
  Dust mask or full face mask where needed.
  Only approved equipment should be used.

EYES AND FACE
  Goggles and dust mask or full face mask where needed.

HANDS, ARMS AND BODY
  Wear gloves and right-fitting overalls.

OTHER CLOTHING AND EQUIPMENT
  – In case of fire : rescue mask : Drager type B 105 st. or equivalent.
  – Hydrogen selenoid H_2Se monitoring : Multigas detector Drager Mod 21/31 or
    equivalent.

B-20

H. PHYSICAL DATA

Material is (at normal conditions) : ☐ liquid ■ solid ☐ gas ☐ • • •	Appearance and odor Yellow transparent Odorless	Packing heat sealed under plastic and packed in cardboard boxes filled with shock absorbing material
Boiling point °C not applicable Melting point °C 1525	Specific gravity $H_2O = 1$ 5.26	Vapor density (AIR = 1) not applicable
Solubility in water % by weight insoluble	pH not applicable	Vapor pressure mmHg at 20 °C not applicable
Evaporation rate not applicable	% volatiles by volume (at 20 °C) not applicable	

I. REACTIVITY DATA

Stability ☐ unstable ■ stable	Conditions to avoid Immersion or contact with acids. Temperatures above 500 °C

Incompatibility (Materials to avoid)
All conditions with H_2Se-formation risks : acids, oxidizing agents, ... Avoid any contact with acids !

Hazardous decomposition products
When heated in air (in case of fire), toxic fumes of selenium oxide (SeO_2) and zinc oxide (ZnO) are formed. When reacted with acids highly toxic and flammable hydrogen selenide (H_2Se) is formed.

Hazardous polymerization ☐ may occur ■ will not occur	Conditions to avoid none

J. ENVIRONMENTAL

EPA : Superfund Amendments and Reauthorization Act of 1986 ("SARA")

1) Sections 302 and 304 (Emergency Planning and Emergency Release Notifications)

   a) CERCLA Hazardous Substance   ■ Yes   ☐ No

       Reportable quantity : Se : 1 lb; Zn : 1 lb

   b) SARA, TITLE III,
       EXTREMELY HAZARDOUS SUBSTANCE   ☐ Yes   ■ No

       Reportable quantity (RQ) : N.A.
       Treshold Planning Quantity (T.P.Q.) : N.A.

2) Sections 311 and 312 (MSDS Submission and Inventory)

   OSHA HAZARD CATEGORIES

   <u>Physical stage</u>   <u>Physical or Health hazard</u>

   pure   ■   fire hazard   ☐
   mixture   ☐   suden release of pressure   ☐
   solid   ■   reactive   ☐
   liquid   ☐   immediate (acute) health hazard   ■
   gas   ☐   delayed (chronic) health hazard   ☐ (not available)

3) Sections 313 and 40 CFR Part 372 (Toxic Chemical Release Report)

   Notification (section 372.45) : If [ ] Yes is checked in this section, this product
   contains one or more toxic chemicals subject to the reporting requirements of
   section 313 of Title III of the Superfund Amendments and Reauthorization Act of
   1986 and 40 CFR Part 372.

   Specific Toxic Chemicals Listing   ☐ Yes   ■ No

   Chemical CAS number : N.A.
   Chemical category : —

   Weight % : > 99 %*
   * This product contains no other toxic chemicals in excess of the applicable "de
     minimis concentration" as specified in § 372.38 (a).

Waste disposal methods must comply with federal, state, and local disposal or
discharge laws.

K. REFERENCES

PERMISSIBLE CONCENTRATION REFERENCES

- OSHA (U.S. Occupational Safety & Health Administration, Time Weighted Average). CFR, January 19, 1989 § 1910 amended Z LIST.

- ACGIH TLV - TWA - American Conference of Governmental Industrial Hygienists (Threshold Limit Value - Time Weighted Average), edition 1988 - 1989.

HAZARD INFORMATION REFERENCES

- Occupational Health Guideline for Chemical Hazards

- US Dept. of Health and Human Services (DHHS)

- US Dept. of Labor (NIOSH) Publication 81-123

- RTECS : Register of Toxic Effects of Chemical Substances, NIOSH, edition April 1989

REGULATIONS REFERENCES

- CERCLA (Comprehensive Environmental Response Compensation and Liability Act-1980 42 U.S.C. 9601 et seq) Hazardous Substances List-40 CFR Table 302.4

- SARA (Superfund Amendments and Reauthorization Act of 1986) Extremely Hazardous Substances List-40 CFR Part 355

GENERAL

- R.A. Zingaro and W.C. Cooper

- Van Nostrand Reinhold Co 1974

L. ADDITIONAL INFORMATION

This Material Safety Data Sheet should be made available by the buyer to each of buyer's plant workers.

The buyer assumes all risk in connection with the use and handling of the material. The seller assumes no responsibility or liability in connection with the information supplied in this sheet or for any damage or injury caused by the material; reasonable safety procedures should be followed. The seller assumes no responsibility for injury or damage caused by use of the material even if reasonable safety procedures are followed. The information contained in this sheet is developed from what is believed to be accurate and reliable sources but the seller makes no warranties, either expressed or implied, and assumes no responsibility for the accuracy or completeness of the data contained herein.

PREPARED BY SOGEM-AFRIMET INC.
DATE PREPARED : 19th March, 1990

AIR LIQUIDE

OBJECTIVE ZERO ACCIDENTS

MATERIAL SAFETY DATA SHEET

PRODUCT INFORMATION

PRODUCT.......................... LASAL 1
TRADE NAME....................... LASAL 1
CHEMICAL NAME.................... Nitrogen
SYNONYMS......................... None
FORMULA.......................... N₂
CHEMICAL FAMILY.................. Inert Gas
MANUFACTURER'S NAME............. Canadian Liquid Air Ltd.
MANUFACTURER'S ADDRESS.......... 1155 Sherbrooke Street West
.... Montreal, Quebec, Canada H3A 1H8
EMERGENCY PHONE NUMBER.......... (514) 878-1667
MOLECULAR WEIGHT................ 28.01
PRODUCT USE..................... LASER; Laser Gas
NA # or UN #.................... UN 1066

HAZARDOUS INGREDIENTS

CHEMICAL IDENTITY	CONCENTRATION	CAS #	LD(50)	LC(50)
Nitrogen	99+%	7727-37-9	None	None

PHYSICAL DATA

PHYSICAL STATE.................. Gas under pressure
ODOUR AND APPEARANCE........... Colorless, odorless gas
ODOUR THRESHOLD................. Odorless
SPECIFIC GRAVITY............... Not applicable (gas)
VAPOUR PRESSURE................ 21.1°C = Above the critical temperature
VAPOUR DENSITY (air=1).......... .967
EVAPORATION RATE............... Not applicable (gas)
BOILING POINT.................. -195.803°C
FREEZING POINT................. -210.002°C
pH............................. Not applicable (gas)
DENSITY (g/ml)................. @ 1 atm 1.1605 kg/m³
COEFFICIENT OF WATER/OIL
   DISTRIBUTION................ @ 20°C Bunsen Coefficient = .01557

FIRE OR EXPLOSION HAZARD

CONDITIONS OF FLAMMABILITY...... Nonflammable gas

2971-0653-0

1

MATERIAL SAFETY DATA SHEET

MEANS OF EXTINCTION............. Nonflammable gas
FLASHPOINT AND METHOD OF
DETERMINATION.................. Nonflammable gas
UPPER EXPLOSION LIMIT (% BY VOL) Nonflammable gas
LOWER EXPLOSION LIMIT (% BY VOL) Nonflammable gas
AUTO-IGNITION TEMPERATURE....... Nonflammable gas
FLAMMABILITY CLASSIFICATION..... Nonflammable gas
HAZARDOUS COMBUSTION PRODUCTS... Nonflammable gas
EXPLOSION DATA................. Nonflammable gas
SENSITIVITY TO STATIC DISCHARGE. No

REACTIVITY DATA

CHEMICAL STABILITY.............. Stable

INCOMPATIBLE MATERIALS.......... None

CONDITIONS OF REACTIVITY........ None

HAZARDOUS DECOMPOSITION PRODUCTS. None

TOXICOLOGICAL PROPERTIES

ROUTES OF ENTRY
  SKIN CONTACT.................. No

  SKIN ABSORPTION.............. No

  EYE.......................... No

  INHALATION................... Effects of exposure to high concentrations so as to displace the oxygen
    in the air necessary for life are headache, dizziness, labored breathing and eventual unconsciousness.

  INGESTION.................... No

ACUTE OVER EXPOSURE EFFECTS..... LASAL 1 is nontoxic but the liberation of a large amount in a confined
  area could displace the amount of oxygen in air necessary to support life.

CHRONIC OVER EXPOSURE EFFECTS... None

MATERIAL SAFETY DATA SHEET

EXPOSURE LIMITS................. LASAL 1 should be considered a simple asphyxiant.
Oxygen levels should be maintained at greater than 18 molar percent at
normal atmospheric pressure which is equivalent to a partial pressure of

135 mm Hg. (ACGIH 1992-1993).
IRRITANCY OF PRODUCT............ No
SENSITIZATION TO MATERIAL....... No
CARCINOGENICITY, REPRODUCTIVE
EFFECTS......................... None
TERATOGENICITY, MUTAGENICITY.... No
TOXICOLOGICALLY SYNERGISTIC
   PRODUCTS..................... None

PREVENTIVE MEASURES

PERSONAL PROTECTIVE EQUIPMENT: Gloves, any material
                                 Safety goggles or glasses
                                 Safety shoes

SPECIFIC ENGINEERING CONTROLS: LASAL 1 is noncorrosive and may be used with any common structural
material.

LEAK AND SPILL PROCEDURES: Evacuate all personnel from affected area. Use appropriate protective
equipment. If leak is in container or container valve, contact the closest Canadian Liquid Air location.

WASTE DISPOSAL: Do not attempt to dispose of waste or unused quantities. Return in the shipping container
properly labeled, with any valve outlet plugs or caps secured and valve protection cap in place to
Canadian Liquid Air for proper disposal. For emergency disposal, contact the closest Canadian Liquid Air
location.

HANDLING PROCEDURES AND EQUIPMENT: Use only in well-ventilated areas. Valve protection caps must remain
in place unless container is secured with valve outlet piped to use point. Do not drag, slide or roll
cylinders. Use a suitable hand truck for cylinder movement. Use a pressure reducing regulator when
connecting cylinder to lower pressure (3,000 psig) piping or systems. Do not heat cylinder by any means
to increase the discharge rate of product from the cylinder. Use a check valve or trap in the discharge
line to prevent hazardous back flow into the cylinder. Do not tamper with (valve) safety device. Close
valve after each use and when empty.

MATERIAL SAFETY DATA SHEET

STORAGE REQUIREMENTS: Protect cylinders from physical damage. Store in cool, dry, well-ventilated area away from heavily trafficked areas and emergency exits. Do not allow the temperature where cylinders are stored to exceed 52°C. Cylinders must be stored upright and firmly secured to prevent falling or being knocked over. Full and empty cylinders should be segregated. Use a "first in - first out" inventory system to prevent full cylinders being stored for excessive periods of time.

TDG CLASSIFICATION................ 2.2

HP CLASSIFICATION................. A

SPECIAL SHIPPING INFORMATION: Always secure cylinders in an upright position before transporting them. NEVER transport cylinders in trucks of vehicles, enclosed vans, truck cabs or in passenger compartments. Transport cylinders secured in open flatbed or in open pick-up type vehicles.

FIRST AID MEASURES

SPECIFIC FIRST AID PROCEDURES: PROMPT MEDICAL ATTENTION IS MANDATORY IN ALL CASES OF OVER EXPOSURE TO LASAL 1. RESCUE PERSONNEL SHOULD BE EQUIPPED WITH SELF-CONTAINED BREATHING APPARATUS.

Inhalation: Conscious persons should be assisted to an uncontaminated area and inhale fresh air. Quick removal from the contaminated area is most important. Unconscious persons should be moved to an uncontaminated area, given assisted resuscitation and supplemental oxygen. Further treatment should be symptomatic and supportive.

PREPARATION INFORMATION

PREPARED BY........................ Safety and Quality Assurance Department
PHONE NUMBER OF PREPARER.......... (514) 842-5431
DATE PREPARED..................... September 1988
LAST REVISION DATE................ July 15 1993

FOR INFORMATION OR MSDS, PLEASE CONTACT YOUR LOCAL C.L.A. OFFICE OR DISTRIBUTOR.

AIR LIQUIDE

OBJECTIVE ZERO ACCIDENTS

MATERIAL SAFETY DATA SHEET

PRODUCT INFORMATION

PRODUCT.......................... LASAL 2
TRADE NAME....................... LASAL 2
CHEMICAL NAME.................... Carbon Dioxide
SYNONYMS......................... Carbon Dioxide
FORMULA.......................... CO$_2$
CHEMICAL FAMILY.................. Carbonate
MANUFACTURER'S NAME.............. Canadian Liquid Air Ltd.
MANUFACTURER'S ADDRESS.......... 1155 Sherbrooke Street West
.... Montreal, Quebec, Canada H3A 1H8
EMERGENCY PHONE NUMBER.......... (514) 878-1667
MOLECULAR WEIGHT................ 44.01
PRODUCT USE..................... LASER, Laser Gas
NA # or UN #.................... UN 1013

HAZARDOUS INGREDIENTS

CHEMICAL IDENTITY	CONCENTRATION	CAS #	LD(50)	LC(50)
Carbon Dioxide	99+%	124-38-9	None	None

PHYSICAL DATA

PHYSICAL STATE.................. Liquid and gas under pressure
ODOUR AND APPEARANCE........... Colorless, odorless gas
ODOUR THRESHOLD................. Odorless gas
SPECIFIC GRAVITY............... Not applicable (gas)
VAPOUR PRESSURE................ @ 21.1°C = 5900 kPa
VAPOUR DENSITY (air=1)......... 1.65
EVAPORATION RATE............... Not applicable (gas)
BOILING POINT.................. Sublimation Point = -78.5°C
FREEZING POINT................. -56.57°C @ 518 kPa
pH............................. Not applicable (gas)
DENSITY (g/ml)................. @ 15°C = 1.977 kg/m^3
COEFFICIENT OF WATER/OIL
   DISTRIBUTION................ @ 20°C Bunsen Coefficient = .8704

FIRE OR EXPLOSION HAZARD

CONDITIONS OF FLAMMABILITY...... Nonflammable gas

MATERIAL SAFETY DATA SHEET

```
MEANS OF EXTINCTION.............. Nonflammable gas
FLASHPOINT AND METHOD OF
DETERMINATION.................... Nonflammable gas
UPPER EXPLOSION LIMIT (% BY VOL). Nonflammable gas
LOWER EXPLOSION LIMIT (% BY VOL). Nonflammable gas
AUTO-IGNITION TEMPERATURE........ Nonflammable gas
FLAMMABILITY CLASSIFICATION...... Nonflammable gas
HAZARDOUS COMBUSTION PRODUCTS.... Nonflammable gas
EXPLOSION DATA................... Nonflammable gas
SENSITIVITY TO STATIC DISCHARGE.. No
```

REACTIVITY DATA

```
CHEMICAL STABILITY.............. Stable

INCOMPATIBLE MATERIALS.......... None

CONDITIONS OF REACTIVITY........ None

HAZARDOUS DECOMPOSITION PRODUCTS  None
```

TOXICOLOGICAL PROPERTIES

```
ROUTES OF ENTRY
    SKIN CONTACT.................. No


    SKIN ABSORPTION.............. No


    EYE.......................... No


    INHALATION...................
```
Low concentrations (3-5 molar %) cause increased respiration and headache. Eight to 15 molar % concentrations cause headache, nausea and vomiting which may lead to unconsciousness if not moved to open air or given oxygen. Higher concentrations cause rapid circulatory insufficiency leading to coma and death.

```
    INGESTION.................... No
```

ACUTE OVER EXPOSURE EFFECTS..... LASAL 2 is the most powerful cerebral vasodilator known. Inhaling large concentrations causes rapid circulatory insufficiency leading to coma and death.

CHRONIC OVER EXPOSURE EFFECTS... Chronic, harmful effects are not known from repeated inhalation of low (3-5 molar %) concentrations.

LASAL 2

MATERIAL SAFETY DATA SHEET

EXPOSURE LIMITS................... TWA = 5,000 Molar PPM; STEL - 30,000 Molar PPM (ACGIH 1992-1993)
IRRITANCY OF PRODUCT............. None
SENSITIZATION TO MATERIAL....... No
CARCINOGENICITY, REPRODUCTIVE
EFFECTS.......................... None
TERATOGENICITY, MUTAGENICITY.... None
TOXICOLOGICALLY SYNERGISTIC
   PRODUCTS...................... None

PREVENTIVE MEASURES

PERSONAL PROTECTIVE EQUIPMENT: Safety goggles or glasses, safety shoes.

SPECIFIC ENGINEERING CONTROLS: Dry LASAL 2 can be handled with most common structural materials. Moist LASAL 2 is corrosive by its formation of carbonic acid. For these applications, 316, 309 and 310 stainless steels may be used as well as Hastelloy® A, B & C and Monel®. Ferrous nickel alloys are slightly corroded.

At normal temperatures LASAL 2 is compatible with most plastics and elastomers.

LEAK AND SPILL PROCEDURES: Evacuate all personnel from affected area. Use appropriate protective equipment. If leak is in user's equipment, be certain to purge piping with an inert gas prior to attempting repairs. If leak is in container or container valve, contact the closest Canadian Liquid Air location.

WASTE DISPOSAL: Do not attempt to dispose of waste or unused quantities. Return in the shipping container properly labeled, with any valve outlet plugs or caps secured and valve protection cap in place to Canadian Liquid Air for proper disposal. For emergency disposal, contact the closest Canadian Liquid Air location.

HANDLING PROCEDURES AND EQUIPMENT: Use only in well-ventilated areas. Valve protection caps must remain in place unless container is secured with valve outlet piped to use point. Do not drag, slide or roll cylinders. Use a suitable hand truck for cylinder movement. Use a pressure reducing regulator when connecting cylinder to lower pressure (<1500 psig) piping or systems. Do not heat cylinder by any means to increase the discharge rate of product from the cylinder. Use a check valve or trap in the discharge line to prevent hazardous back flow into the cylinder. Keep cylinder away from heat and flame. Do not tamper with (valve) safety device. Close valve after use and when empty.

2971-0656-4   3

LASAL 2

MATERIAL SAFETY DATA SHEET

STORAGE REQUIREMENTS: Protect cylinders from physical damage. Store in cool, dry, well-ventilated area of non combustible construction away from heavily trafficked areas and emergency exits. Do not allow the temperature where cylinders are stored to exceed 52°C. Cylinders must be stored upright and firmly secured to prevent falling or being knocked over. Full and empty cylinders should be segregated. Use a "first in - first out" inventory system to prevent full cylinders being stored for excessive periods of time.

TDG CLASSIFICATION............... 2.2

HP CLASSIFICATION................ A

SPECIAL SHIPPING INFORMATION: Always secure cylinders in an upright position before transporting them. NEVER transporter cylinders in trunks of vehicles, enclosed vans, truck cabs or in passenger compartments. Transport cylinders secured in open flatbed or in open pick-up type vehicles.

FIRST AID MEASURES

SPECIFIC FIRST AID PROCEDURES: PROMPT MEDICAL ATTENTION IS MANDATORY IN ALL CASES OF OVER EXPOSURE TO LASAL 2. RESCUE PERSONNEL SHOULD BE EQUIPPED WITH SELF-CONTAINED BREATHING APPARATUS.

Inhalation: Conscious persons should be assisted to an uncontaminated area and inhale fresh air. Quick removal from the contaminated area is most important. Unconscious persons should be moved to an uncontaminated area, given assisted resuscitation and supplemental oxygen. Assure that vomited material does not obstruct the airway by use of positional drainage. Medical assistance should be sought immediately.

PREPARATION INFORMATION

PREPARED BY....................... Safety and Quality Assurance Department
PHONE NUMBER OF PREPARER.......... (514) 842-5431
DATE PREPARED..................... September 1988
LAST REVISION DATE................ July 15 1993

FOR INFORMATION OR MSDS, PLEASE CONTACT YOUR LOCAL C.L.A. OFFICE OR DISTRIBUTOR.

THE INFORMATION, RECOMMENDATIONS AND DATA CONTAINED IN THIS DOCUMENT ARE INTENDED TO BE USED BY PROPERLY TRAINED AND QUALIFIED PERSONNEL ONLY AND AT THEIR SOLE RISKS AND DISCRETION. THE INFORMATION, RECOMMENDATIONS AND DATA HEREIN CONTAINED ARE DERIVED FROM SOURCES WHICH WE BELIEVE TO BE RELIABLE. HOWEVER, CANADIAN LIQUID AIR LTD. MAKES NO REPRESENTATION AND GIVES NO WARRANTY OF ANY KIND WHATSOEVER WITH RESPECT TO THEIR ACCURACY OR COMPLETENESS AND ASSUMES NO LIABILITY FOR DAMAGES OR LOSS ARISING DIRECTLY OR INDIRECTLY FROM THEIR USE, WHETHER PROPER OR IMPROPER.

2971-0656-4   4

AIR LIQUIDE

OBJECTIVE
ZERO
ACCIDENTS

MATERIAL SAFETY DATA SHEET

PRODUCT INFORMATION

PRODUCT............................ LASAL 4
TRADE NAME........................ LASAL 4
CHEMICAL NAME.................... Helium
SYNONYMS......................... Helium, Compressed
FORMULA.......................... He
CHEMICAL FAMILY.................. Inert Gas
MANUFACTURER'S NAME............. Canadian Liquid Air Ltd.
MANUFACTURER'S ADDRESS.......... 1155 Sherbrooke Street West
.... Montreal, Quebec, Canada H3A 1H8
EMERGENCY PHONE NUMBER.......... (514) 878-1667
MOLECULAR WEIGHT................ 4.00
PRODUCT USE..................... LASER; Laser Gas
NA # or UN #.................... UN 1046

HAZARDOUS INGREDIENTS

CHEMICAL IDENTITY	CONCENTRATION	CAS #	LD(50)	LC(50)
Helium	99+%	7440-59-7	None	None

PHYSICAL DATA

PHYSICAL STATE................... Gas under pressure
ODOUR AND APPEARANCE............ Colorless, odorless gas
ODOUR THRESHOLD................. Odorless
SPECIFIC GRAVITY................ Not applicable (gas)
VAPOUR PRESSURE................. Not applicable (gas)
VAPOUR DENSITY (air=1).......... .138
EVAPORATION RATE................ Not applicable (gas)
BOILING POINT................... -268.96°C
FREEZING POINT.................. -271.387°C @ 3013 kPa
pH.............................. Not applicable (gas)
DENSITY (g/ml).................. @ 15.5°C = .167 kg/m³
COEFFICIENT OF WATER/OIL
    DISTRIBUTION................ @ 20°C Bunsen Coefficient = .0086

FIRE OR EXPLOSION HAZARD

CONDITIONS OF FLAMMABILITY....... Nonflammable gas

2971-0662-9

1

MATERIAL SAFETY DATA SHEET

MEANS OF EXTINCTION............... Nonflammable gas
FLASHPOINT AND METHOD OF
DETERMINATION.................... Nonflammable gas
UPPER EXPLOSION LIMIT (% BY VOL) Nonflammable gas
LOWER EXPLOSION LIMIT (% BY VOL) Nonflammable gas
AUTO-IGNITION TEMPERATURE........ Nonflammable gas
FLAMMABILITY CLASSIFICATION..... Nonflammable gas
HAZARDOUS COMBUSTION PRODUCTS... Nonflammable gas
EXPLOSION DATA.................. Nonflammable gas
SENSITIVITY TO STATIC DISCHARGE. No

REACTIVITY DATA

CHEMICAL STABILITY............... Stable

INCOMPATIBLE MATERIALS........... None

CONDITIONS OF REACTIVITY......... None

HAZARDOUS DECOMPOSITION PRODUCTS. None

TOXICOLOGICAL PROPERTIES

ROUTES OF ENTRY
SKIN CONTACT.................. No

SKIN ABSORPTION............... No

EYE.......................... No

INHALATION................... Effects of exposure to high concentrations so as to displace the oxygen in the air necessary for life are headache, dizziness, labored breathing and eventual unconsciousness. Breathing mixtures of LASAL 4 with adequate oxygen to support life modifies the voice sound so that it is higher "pitched".

INGESTION.................... No

ACUTE OVER EXPOSURE EFFECTS..... LASAL 4 is nontoxic but the liberation of a large amount in a confined area could displace the amount of oxygen in air necessary to support life.

CHRONIC OVER EXPOSURE EFFECTS... None

MATERIAL SAFETY DATA SHEET

EXPOSURE LIMITS................. LASAL 4 is defined as a simple asphyxiant. Oxygen levels should be maintained at greater than 18 molar percent at normal atmospheric pressure which is equivalent to a partial pressure of 135 mm Hg. (ACGIH 1992-1993).

IRRITANCY OF PRODUCT............ None

SENSITIZATION TO MATERIAL....... No

CARCINOGENICITY, REPRODUCTIVE
EFFECTS........................ None

TERATOGENICITY, MUTAGENICITY.... No

TOXICOLOGICALLY SYNERGISTIC
   PRODUCTS...................... None

PREVENTIVE MEASURES

PERSONAL PROTECTIVE EQUIPMENT: Protective gloves
                                    Safety goggles or glasses
                                    Safety shoes

SPECIFIC ENGINEERING CONTROLS: LASAL 4 is noncorrosive and may be used with any common structural material.

LEAK AND SPILL PROCEDURES: Evacuate all personnel from affected area. Use appropriate protective equipment. If leak is in container or container valve, contact the closest Canadian Liquid Air location.

WASTE DISPOSAL: Do not attempt to dispose of waste or unused quantities. Return in the shipping container properly labeled, with any valve outlet plugs or caps secured and valve protection cap in place to Canadian Liquid Air for proper disposal. For emergency disposal, contact the closest Canadian Liquid Air location.

HANDLING PROCEDURES AND EQUIPMENT: Use only in well-ventilated areas. Valve protection caps must remain in place unless container is secured with valve outlet piped to use point. Do not drag, slide or roll cylinders. Use a suitable hand truck for cylinder movement. Use a pressure reducing regulator when connecting cylinder to lower pressure (<3,000 psig) piping or systems. Do not heat cylinder by any means to increase the discharge rate of product from the cylinder. Use a check valve or trap in the discharge line to prevent hazardous back flow into the cylinder. Do not tamper with (valve) safety device. Close valve after each use and when empty.

MATERIAL SAFETY DATA SHEET

STORAGE REQUIREMENTS: Protect cylinders from physical damage. Store in cool, dry, well-ventilated area away from heavily trafficked areas and emergency exits. Do not allow the temperature where cylinders are stored to exceed 52°C. Cylinders must be stored upright and firmly secured to prevent falling or being knocked over. Full and empty cylinders should be segregated. Use a "first in - first out" inventory system to prevent full cylinders being stored for excessive periods of time.

TDG CLASSIFICATION................ 2.2

HP CLASSIFICATION................ A

SPECIAL SHIPPING INFORMATION: Always secure cylinders in an upright position before transporting them. NEVER transport cylinders in trucks of vehicles, enclosed vans, truck cabs or in passenger compartments. Transport cylinders secured in open flatbed or in open pick-up type vehicles.

FIRST AID MEASURES

SPECIFIC FIRST AID PROCEDURES: PROMPT MEDICAL ATTENTION IS MANDATORY IN ALL CASES OF OVER EXPOSURE TO LASAL 4. RESCUE PERSONNEL SHOULD BE EQUIPPED WITH SELF-CONTAINED BREATHING APPARATUS.

Inhalation: Conscious persons should be assisted to an uncontaminated area and inhale fresh air. Quick removal from the contaminated area is most important. Unconscious persons should be moved to an uncontaminated area, given assisted resuscitation and supplemental oxygen. Further treatment should be symptomatic and supportive.

PREPARATION INFORMATION

PREPARED BY......................... Safety and Quality Assurance Department
PHONE NUMBER OF PREPARER........... (514) 842-5431
DATE PREPARED...................... September 1988
LAST REVISION DATE................ July 15 1993

FOR INFORMATION OR MSDS, PLEASE CONTACT YOUR LOCAL C.L.A. OFFICE OR DISTRIBUTOR.

HS COOLING CUTTING

OPERATOR'S MANUAL

AMADA

HS cooling cut

Contentes

HS cooling cutting

1. Outline

Efficiently cooling the cutting point part becomes possible by using The HS cooling cutting is a special sensor head (future "HS cooling cutting head" which added the function to gush the water to cool the cutting material) and the temperature of the cutting material is stabilized.

The laser cutting which is the heat processing raises the temperature while heating and processing the material by the cut process.

Becomes a big trouble for this to establish and to process a steady laser processing minutely.

The HS cooling cutting enables a steadier laser cutting and as follows, demonstrates the recorded effect.

- Defective rate decrease of pierced earring processing with thickness (9mm or more)
- The stability improvement of cutting with thickness (9mm or more, and for stacked -sheet cutting.)
- Melting prevention in minute processing of edge processing etc.
- Processing speed improvement of small holes processing

*** The HS cooling cutting head is controlled as the same controller as the Z axis standard sensor HS-98.

2. Important Precautions

●Please clean the inner nozzle and the outer nozzle before using HS cooling cutting head. Please install at the head after confirming the head internal and inside of the outer nozzle are cleaned due to air blow etc. and there is no adhesion such as dross when you use the HS cooling cutting head. Damage of the malfunction of the following function and the head is caused.

●Please gush cooling water and use the HS cooling cutting head.
The processing head used is a head only for the HS cooling cutting. Dross invades the space between the inner nozzle and the outer nozzle when using without gushing cooling water from the outer nozzle. Damage of the malfunction of the following function and the head is caused.

●Please mix a specified rust prevention medicine with cooling water and use what adjusted to the density of 1-3%. The generation degree of rust might be different according to the cutting material。 In this case, please increase the amount of the mixing rust prevention medicine and raise the density up to 3%. However, when the density becomes 3% or more, the malfunction of the sensor is caused.

●The processing head used to cut the HS cooling is a processing head only for the HS cooling cutting. Please exchange for a standard head and process when you do the method of processing the following.

Clean cutting

aluminum cutting

Ｅ Ｚ cutting

●Please restart after securing the nozzle gap enough of the rise of Z axis when the processing interruption is done by the reason for the processing defect generation etc. with the "RESET" key or "Stop" button by 25mm or more. The nozzle gap restarts at the position of the height of following. Cooling water adheres to the lens. Causing by which lens is remarkably deteriorated

●Please consider to maintenance and the check of the processing machine enough after processing in the HS cooling cutting.

The damage to the machine main body with rust is reduced by mixing the rust prevention medicine with cooling water. Please remove the moisture which adheres to the processing machine (especially, driving part) and refuel grease to driving part after processing .

●Please execute regular maintenance of piping.

Cooling water by which the rust prevention medicine is mixed becomes an adhesion thing with a high viscosity when drying. Therefore, please do the cleaning maintenance regularly to prevent each piping part stopped up. Please refer to 7.2.2 cooling water tank and piping system" for details.

3. Specification

lens which can be used	Lens diameter D	D=1.5"、2.0"
	Focus length Lf	Lf=5"、7.5"、10"
Kind of nozzle	Inner nozzle (WACS nozzle) (※1)	W nozzle (It is attached by the standard 3 pieces) (※2)
	Outer nozzle	(It is attached by the standard 2 pieces)
Cooling water	Capacity of tank	10 liters
	Air supply pressure	$0.3\sim0.4$ MPa $\{3\sim4$ kgf／cm$^2\}$
	Rust prevention medicine	puretonW-3(Sugimura chemical cryptomeria industrial company) (※3)
	Amount of consumption	$0.01\sim0.07$ L/min $\{10\sim70$mL／min$\}$
Material for processing	Material	Mild steel board (SPCC, SPHC, SS400, and SK material, etc.)
	thickness	The same specification as mild steel board cutting ability of this machine
Instruction nozzle gap		0.3-2.0mm recommendation 1.5mm

※1 Different from the nozzle for Z axis sensor HS-98. Moreover, the nozzle for Z axis sensor HS—98 cannot be used for the HS cooling cutting head.

※2 Please do the centering work of the nozzle accurately when you use W nozzle. The hole of the nozzle cannot be damaged by the laser beam when centering the nozzle is inaccurate and the performance of W nozzle be demonstrated enough.

※3 Please refer to "9.9 appending material" for details.

4. Parts Identification

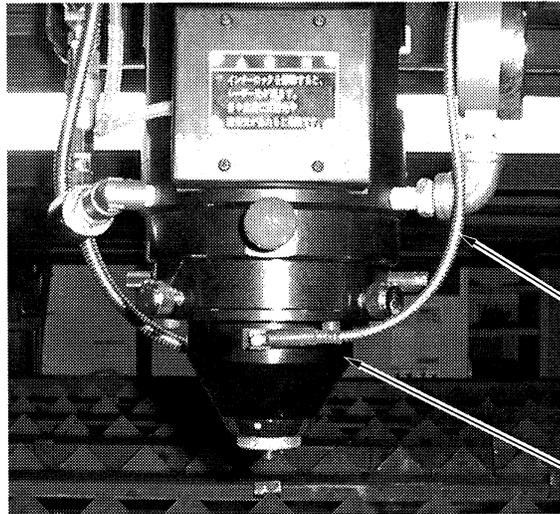The arrangement of each equipment might be different depending on the model.

4.1 Cooling water tank piping part

Air cutoff valve knob
Regulator
Air cutoff valve
Air inlet
Pressure adjust knob
Water inlet
Y Strainer
Reservoir

4.2 Processing head

Flow adjusting knob

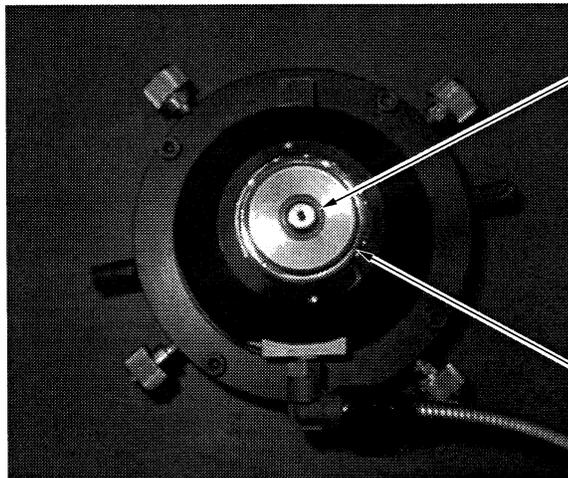Air tube

Water tube

Mixing block

Delivery hose
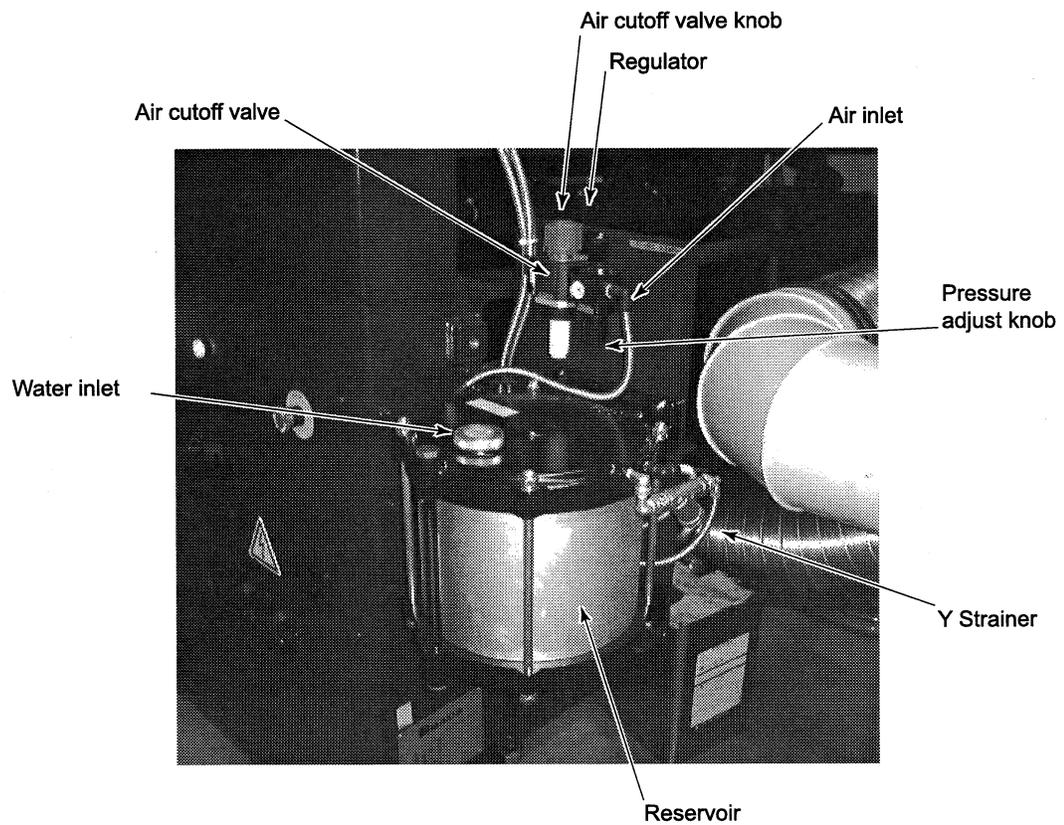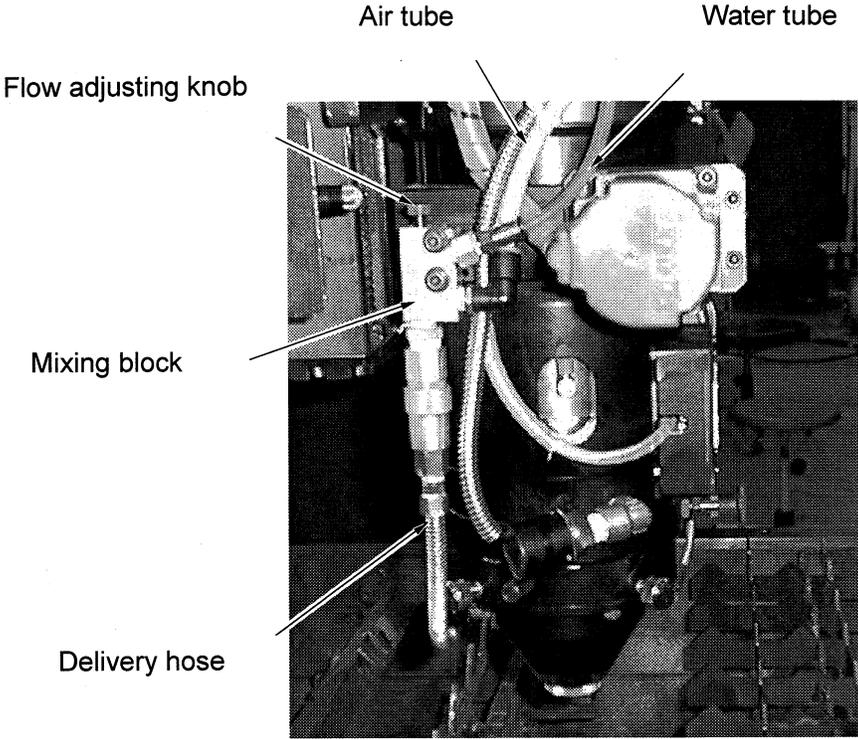
4.3   HS cooling cutting head

Sensor cable

HS cooling
Cutting head

Inner nozzle

Outer nozzle
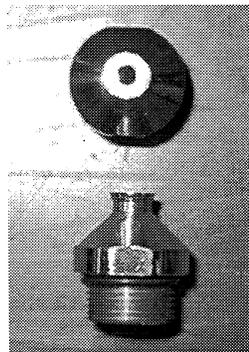
Inner nozzle (WACS
nozzle)
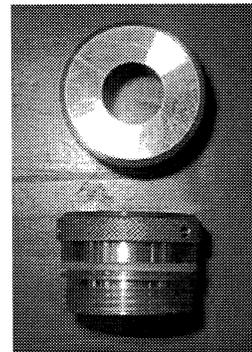
Outer nozzle

4.4 Meter of flowing quantity of cooling water

Flow meter

Flow meter
adjust knob
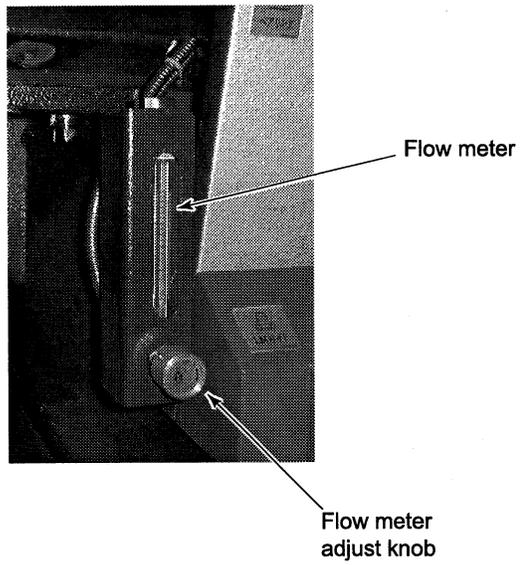
5. Adjustments

Please do the adjustment confirmation of each part according to the following procedures before using the HS cooling cutting head.

⚠ **Danger**	A small amout of laser beam may leak during these adjustmets. Never put your hand under the nozzle when the shutter is enabled, or you may be exposed to the laser beam.

1
Confirmation of cooling water tank
Maintenance of HS cooling cutting head

2
Execution of operation confirmation 08003 of HS cooling cutting head

Please do the adjustment work of 3-5 if not normally operating by two.

3
Angle of spray degree of cooling water and adjustment confirmation of volume of water

4
Execution of exhaust 08002 of cooling water which remains in head

5
Execution of adjustment 08010 of calibration.

6
Centering adjustment confirmation of laser beam and nozzle

The confirmation and the adjustment work of the HS cooling cutting head are ends in the above.

5.1 Maintenance of the cooling water tank and the Hs cooling cutting head.

5.1.1 Confirmation of cooling water tank

Please confirm the volume of water of cooling water.

Please confirm there is cooling water (1% or more in the density of the rust prevention medicine) in the cooling water tank (10 liters in capacity). Please make the cooling water of 3% or less in the density when the remainder is a little and replenish.

Please rotate the exhaust valve knob (red) by 90 degree and liberate the pressure of air and replenish from the water supply entrance on the cooling water tank. The table below shows the amount of mixing the rust prevention medicine.

Density of cooling water of rust prevention medicine	To the water service water 5 liters	To the water service water 10 liters
1%	50cc	100cc
2%	100cc	200cc
3%	150cc	300cc

5.1.2 Confirmation and adjustment of supply air pressure to cooling water tank

Please confirm the pressure of the supply air is a pressure gauge of the regulator and 3-4kgf/cm2. Please turn the air regulator adjustment knob and adjust in case of other setting pressure so that pressure may become 3-4kgf/cm2.

5.1.3   Maintenance of HS cooling cutting head

Please maintain the HS cooling cutting head according to an undermentioned procedure.

1. The HS cooling cutting head is detached.
   The detaching method is the same as a standard head. The cooling water tube is removed from the coupler of the mixer. The sensor cable is removed in the head connector.

2. The HS cooling cutting head is inversely put on a steady work stand.

3. The outer nozzle and the inner nozzle are removed.

4. The inner nozzle and the outer nozzle squeak and air is blown out due to air gun and wiping is creaky with wess.

5. Installs at the head by using spanner (width of 17mm) after it is confirmed that O ring (model S12.5) is installed at the inner nozzle. Please occupy until O ring disappears.

6. Tightens by the hand until bumping to the point part of the head after it is confirmed that O ring (model 4C-1028 (white)) is installed at the outer nozzle and screws in.

Important

●The HS cooling cutting head side screw can be done in the nonmetal.

Please do not screw in forcibly.

Damage of the screw is caused.

7. The HS cooling cutting head is installed. The installation method is the same as a standard head.

5.2 Operation confirmation of HS cooling cutting head

Please do the operation confirmation of the HS cooling cutting head and the minuteness adjustment of the amount of cooling water by using user macro O8003 according to an undermentioned procedure.

1. The oxygen low pressure of the assistance gas is set in 0.5kgf/cm2.

   This operation is unnecessary when equipped with the NC assist gas control of the option.

2. "Shutter enable" key to the NC operation panel is made "ON".

3. User macro O8003 is made to be executed.

   The processing head descends, and becomes the height of 1.5mm from the surface of the material. Moreover, cooling water is gushed for 3600 seconds.

4. The volume of water of cooling water is finally adjusted.

   Flowing so that the cooling water gushed on the material may pull the string is a proper quantity. Please adjust the volume of water with the knob of the adjustment of the volume of water of the flowing quantity meter. Please do not adjust the volume of water adjustment switch of the mixer.

5. Whether the sensor does the stability operation is confirmed, "Stop" button is pushed, and the program is stopped.

   Please do "Centering adjustment of 9.5.6 nozzles" when the sensor does the stability operation.

   Please adjust minuteness as follows and confirm whether the sensor does the stability operation from clause 3 again if the sensor does not do the stability operation.

   · Turns in the direction where the knob of the adjustment of the volume of water of the flowing quantity meter is closed and the volume of water is decreased.

   · Turns slightly in the direction where the outer nozzle is loosened and the space distance of the inner nozzle and the outer nozzle is expanded. (The cooling water angle of spray degree is slightly expanded)

· The water is added to the water tank and the density of cooling water of the rust prevention medicine is reduced to 3% or less

. Please do undermentioned work and do this confirmation again afterwards if you do not do the stability operation by the minuteness adjustment. (5.3 Adjusting the coolant spray angle and volume
5.4 Exhaust of cooling water which remains in head
5.5 Adjustment of Z axis sensor (calibration))

Please do the operation confirmation again after wards.

5.3 Adjusting the coolant spray angle and volume

By using user macro O8000, adjust the angle and flow rate of coolant.

5.3.1 Volume of water adjustment of cooling water

Please do the volume of water adjustment of cooling water according to an undermentioned procedure.

1. The volume of water adjustment switch of the knob of the adjustment of the volume of water of the flowing quantity meter and the mixer is completely opened.

2. After lighting pushing "TRACE OFF" button of the NC operation panel, Z axis is moved to the height of about 150mm in a manual mode or the MDI mode. (Cooling water does not gush at the Z origin position.

3. The oxygen low pressure of the assistance gas is set in 0.5kgf/cm2 This operation is unnecessary when equipped with the NC assistance gas control of the option.

4. "SHUTTER" key to the NC operation board is made "ON".

5. O8000 is executed.

   Fogged cooling water gushes from the space between the inner nozzle and the outer nozzle.

6. Please adjust for the display of the flowing quantity meter to become about 80cc/min in the above-mentioned by picking up the mixer the volume of water adjustment. It is a direction where flowing quantity decreases when turning clockwise.

7. Please adjust for the display of the flowing quantity meter to become about 20cc/min in the above-mentioned with the knob of the adjustment of the volume of water of the flowing quantity meter. It is a direction where flowing quantity decreases when turning clockwise.

14

5.3.2 Angle of spray degree adjustment of cooling water

The angle of spray degree of cooling water is adjusted according to an undermentioned procedure.

⚠️ **DANGER** ● When this program is running,the laser beam is emitted! Keep your hands away from the nozzle/beam area.

---

1. The outer nozzle screws in until bumping to the point part of the head.

2. O8000 is executed.
   Fogged cooling water gushes from the space between the inner nozzle and the outer nozzle. Please confirm the angle of spray degree of the gushing cooling water by watching. The angle of spray degree of cooling water is decided by the space between the inner nozzle and the outer nozzle. The gushing angle changes with ①→ ② → ③ if the outer nozzle is loosened.
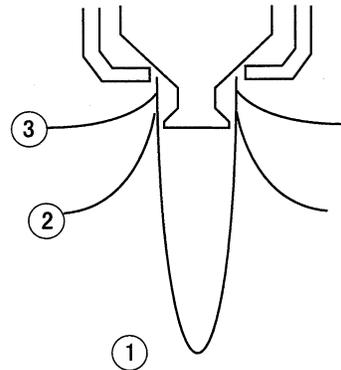
The atomization of cooling water is not made uniform and turns in the inner nozzle and the state of photograph 1 is crowded. In such states of atomization, the following operation in the cutting processing is not accurately done. Moreover, cooling water enters the cutting part and the cutting quality is decreased. Please turn in the direction where the outer nozzle is loosened and expand the angle of spray degree.
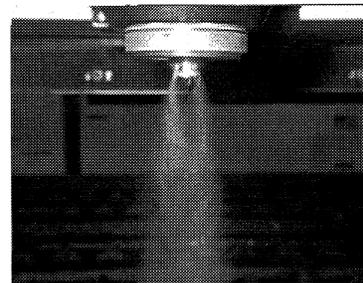
Figure 1

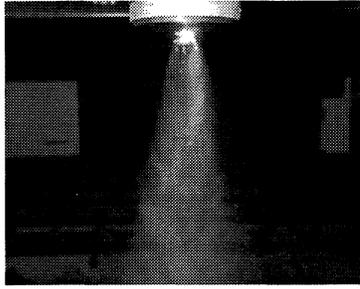The state of photograph 2 and 3 shows the best atomization.
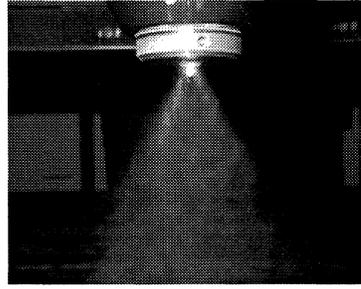
Figure 2

Figure 3

The atomization of cooling water extends too much in the state of photograph 4 because the space between the inner nozzle and the outer nozzle is too wide. The processing point part is hardly cooled in such states of atomization and the HS cooling cutting is not effective. Please turn in the direction where the outer nozzle is tightened and narrow the space with the inner nozzle.
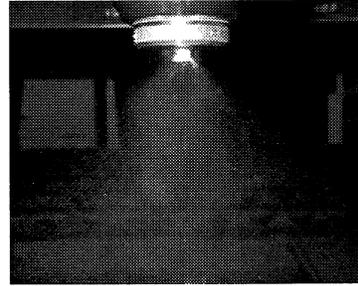

Figure 4

5.4 Exhaust of cooling water which remains in head

Please make user macro O8002 executed before the HS cooling cutting head is calibratined and exhaust the cooling water which remains in the head.

Important
_____

● Accurate calibration cannot be done when cooling water remains the head internal and in the outer nozzle when calibration is adjusted and the malfunction of the sensor function is caused.

1. The oxygen decrease pressure of the assistance gas is set in 0.05 MPa {0.5kgf/cm^2.}

This operation is unnecessary when equipped with the NC assistance gas control of the option.

2. "SHUTTER" key to the NC operation panel is made "ON".

3. User macro O8002 is made to be executed.

Z axis returns automatically the Z origin point and exhausts the cooling water which remains in the head. Exhaust time is for 75 seconds

5.5   Adjustment of Z axis sensor (Calibration)

Calibration means the nozzle gap and the sensor output signal are proofread.
the following cases,   calibration is necessary.

  - When you exchange the sensor nozzle

- When you exchange sensor head.

- When you exchange the sensor cable

- An instruction value and an actual nozzle gap value more than control accuracy (±0.2mm) when differing.

Important

● The operation begins in calibration program after the head descends up to the height of Z=25mm. Please do not do calibration in the material in the state for the height of the surface to exceed Z=25mm with a solid thing and a treatment device. The head collides with the material and the head and the material are damaged.

N o t e

● It is for program execution to turn off "Start" button "Start" The data cannot be cleared when the "RESET" key and "Stop" button are pushed before the button is turned off and calibration be completed correctly.

● Please use the very big one for the material used when adjusting with the mild steel of the board thickness 2.3mm or more compared with the nozzle.

● Please do calibration over again after confirming the dirt of loosening of the nozzle and the cable and nozzles when the alarm is generated.

*** Please adjust Z axis sensor according to an undermentioned procedure.

    1. The starting point returns Z axis.   Return the Z axis to its origin.

    2. The material is clamped to the table.

    3. "TRACE OFF"   button is pushed and the lamp of the button is lit.

    4. The head is moved to the upper part of the material.

    5. User macro O8010 is executed.

The head descends up to the height of Z=25mm by fast-forwarding.

The head descends from the height and comes in contact with the material.

The writing work of the data is done though the operation of the head ends here. About 10 seconds pass.

"Start" When the button is turned off, it is calibration end.

30 - 40 seconds pass as a whole.

6. "TRACE OFF" The lamp of the button is turned off pushing the button.

5.6   Centering adjustment of nozzle

Please center the nozzle just like a usual processing head. Please refer to the owner guide of this processing machine.

6   Using HS-WACS System

6.1   Program operation

Please confirm the following points after adjusting each part and use just like a standard head when processing by the HS cooling cutting head.

• Wacs of the processing condition file used for the program is set in "ON".

• "Caliblation" button of the NC operation panel is turned off (invalidity). The processing must begin as usual after confirming.

6.2 Processing after operation

Please remove the moisture which adheres to the machine and the material after processing . Please refer to "7.2.3 cutting machine " for details. When you do the following processing

When a standard head is used, it is a putting changing into a standard head.

*** Please go without forgetting the adjustment of Z axis sensor back.

7. Cleaning the HS-WACS System

7.1 Maintenance table

I t e m s		Daily	Weekly	Monthly
HS cooling cutting head	Inner nozzle	O		
	Outer nozzle	O		
	Head appearance	O		
Cooling water tank and piping system	Volume of water of cooling water	O		
	Density of cooling water of rust prevention medicine	O		
	Cooling water tank			O
	Piping of cooling water			O
	Y -Strainer			O
Processing machine main body	Refueling of X and Y axis (ball screw and LM guide)		O	
	Maintenance around processing table		O	
	Maintenance of clamps	O		
	Maintenance of chip conveyer	O		

7.2 Maintenance procedures

7.2.1 HS cooling cutting head

Please check the following parts and exchange if necessary. After exchanging, it is necessary to do the adjustment procedure over again as it is one. Please refer to "5 adjustments".

Inner nozzle

Please confirm the presence of the damage of the point part of the nozzle and the transformation of the hole shape. The damage of the shape of the point part influences the state of atomization of cooling water. Moreover, the transformation of the hole shape influences the cutting quality.

When damage is cruel, it is necessary to exchange. Please order by the following names when ordering.

Nozzle name	Model of necessary O ring
HS-WACS W Nozzle	S12.5 （Black）

Outer nozzle

Please confirm damage, the inside of the nozzle in the edge part in the nozzle, and the presence of the dross adhesion to the screw. The inside edge part damage of the nozzle influences the state of atomization of cooling water. Moreover, the damage of the head side outer nozzle installation screw and the malfunction of the sensor function are caused when installing at the head with dross adhered to the nozzle.

When damage is cruel, it is necessary to exchange. Please order by the following names when ordering.

Nozzle name	Model of necessary O ring
HS-WACS Outer nozzle	4C-1028 （White）

Head appearance

The HS cooling cutting head is an electrostatic capacity type sensor which uses the principle of the capacitor. It is a seriously delicate device while an efficient function is possessed. Please blow out dross and the cooling water, etc. which adhere to sensor head in air when ending and wipe with a dry cloth and calculate. Moreover, it is necessary to throw the head and when damages or the outer nozzle screws forcibly in and the screw on the head side is damaged, exchange sensor head.

Please check whether there is damage for the connector for the sensor cable of sensor head. Especially, when a central pin bends largely and damage is cruel, it is necessary to exchange the connector.

7.2.2 Cooling water tank and piping system

Volume of water of cooling water

Dross etc. invade in the head when using and the malfunction of the sensor function is caused without gushing cooling water when the HS cooling cutting head is used.

Please confirm whether there is an amount of cooling water before start of work enough.

Density of cooling water of rust prevention medicine

Please adjust the density of the rust prevention medicine of the cooling water used to 3% or less. When the density becomes any more, the malfunction of the sensor function is caused.

The density rises by the evaporation of moisture if does not use for a long term. Please replenish with the water service water if there is a necessity after confirming before using and adjust the density.

Cooling water tank, piping, and Y strainer.

The rust prevention medicine which mixes with cooling water is an organic system. Therefore, the solid quality with oils and fats is generated when not using for a long term and nor entering the left state. This causes stopped up of piping with the adhesion thing with a high viscosity. Please wash the cooling water tank and piping once a month according to an undermentioned procedure.

1. Cooling water in the cooling water tank is drained from drain under the tank.

2. Piping in the tank is washed by the clean water.

3. After the tightening bolt is removed, inside stainer is taken out, and the adhesion thing is removed with the brush etc. , Y-stainer is washed by the water service water.

4. Y-stainer is installed after washing and the tightening bolt is installed.

5. It is done that cooling water with the rust prevention medicine is not allotted in the cooling water tank.

Please do not to allot the water service water in the cooling water tank after draining cooling water in the cooling water tank from drain under the tank and washing with the clean water if you do not schedule the HS cooling cutting function to be used for a long term.

7.2.3 Cutting machine

Please consider to the maintenance check of the processing machine enough after processing in the HS cooling cutting head.

Please the moisture which adheres to the processing machine (especially, driving part) is removed and refuel grease to driving part after processing though the damage to the machine main body with rust is reduced by mixing the rust prevention medicine with cooling water.

8. NC code and program

8.1 G codes and M codes

G code and M code which relates to the HS cooling cutting are tables below.

Sensor instruction	G 3 2 R_	Activete Z-axis follow mode (R: heightstandoff)
	G 3 3	Disable Z-axis follow mode
Coolant instruction	M 7 3 2	Outer gas gush mode
	M 7 3 3	Outer gas stop
	M 7 3 8	HS cooling cutting effective
	M 7 3 9	HS cooling cutting invalidity

8.2 Program

The program and the user macro which relates to the HS cooling cutting are recorded.

For centering adjustment P r g

```
O7000   (NOZZLE CENTER) ;
M100 ;
M739 ;
#32=1. ;
IF[#4006NE20. ]GOTO1 ;
#32=25. 4 ;
N1  G00  Z[25. /#32] ;
G31  P5  T1 ;
G24  S300  P100  Q50  R. 3 ;
M101 ;
G00  Z[100. /#32] ;
M30 ;
```

Program for adjusting spray angle and flow rate

```
O8000  (MIST REGULATION) ;
G93  Z#5023 ;
M100 ;
G31  P5  T30 ;
G04  X1. ;
M738 ;
G04  X30. ;
M739 ;
G04  X2. ;
G31  P0 ;
M30 ;
```

Program to purge coolant from the head.

```
0 8 0 0 2    (H S — W A C S  H E A D  W A T E R  F L U S H I N G) ;
G 9 1  G 8 8  Z 0. ;
G 9 0 ;
G 9 3  Z # 5 0 2 3 ;
M 1 0 0 ;
M 7 3 9 ;
# 1 = 1 ;
W H I L E [# 1 L E 5] D O 1 ;
M 7 3 2 ;
G 3 1  P 1  T 5 0 ;
G 0 4  X 1 0. ;
M 7 3 3 ;
G 0 4  X 5. ;
# 1 = # 1 + 1 ;
E N D 1 ;
M 1 0 1 ;
M 3 0 ;
```

Program to test the WACS system for proper operation

```
0 8 0 0 3    (H S — W A C S  M O T I O N  C H E C K) ;
# 3 2 = 1. ;
I F [# 4 0 0 6 N E 2 0. ] G O T O 1 ;
# 3 2 = 2 5. 4 ;
N 1 ;
G 9 0  G 9 2  X 0.  Y 0. ;
M 1 0 0 ;
G 0 0  Z [5 0. ∕ # 3 2] ;
G 9 3  Z # 5 0 2 3 ;
G 3 2  R [1. 5 ∕ # 3 2] ;
G 3 1  P 1  T 5 ;
M 7 3 8 ;
G 0 4  X 3 6 0 0. ;
M 7 3 9 ;
M 1 0 1 ;
M 3 0 ;
```

Material Safety Data Sheet

Section 1   Product and Company Identification

Sugimura Chemical Industrial Co., Ltd.   Phone 052-211-6000
12-4 1-Chome Marunouchi Naka-Ku Nagoya, Japan

Product Name: **Preton W-3A**   Chemical Family: Aqueous Synthetic

Prepared by: Scott A. Goeglein   February 11, 1999

Section 2   Composition / Hazardous Ingredients Information

Ingredient   TLV / PEL*   CAS #

The exact chemical identities and percentages are being withheld as trade secrets as provided under 29CFR 1910.1200

Section 3   Physical and Chemical Properties

Color:	Brown	Vapor Pressure:		Solubility in water:	Soluble
Appearance:	Clear Liquid	% Volatile by Volume:		Evaporation Rate	
Odor:	Characteristic	Vapor Density(air=1):	>1	(Butyl Acetate=1):	<1
Boiling Point:	210 ° F	Reactivity in Water:	Non-reactive	Specific Gravity:	1.10
Melting Point:		Density, #/gal:	9.160		

Section 4   Fire Fighting Measures

Flammable Properties:
Flash point: None ° F, (ASTM D-56)   Flammable limits in air: N/A   Auto ignition temperature: N/A
Extinguishing media: CO_2, dry chemical, foam
Special fire fighting measure:
Procedures for an oil fire should be followed. Use self contained breathing apparatus. Use foam or dry chemical to extinguish fire. Water may be used only to keep surrounding containers cool.

Section 5   Hazards Identification

Primary Routes of Entry:
Skin: Tests on similar materials indicate that no significant adverse health effects are expected to occur with short term exposure.
Eyes: Tests on similar materials suggests that minimal irritation may occur on contact.
Ingestion: Tests on similar materials indicate that no significant adverse effects expected. Practically non-toxic.
Inhalation: Tests on similar materials indicate no acute effects are expected.

Section 6   First Aid Measures

Eyes: Flush eyes immediately with water for at least 15minutes or until irritation subsides. If irritation persists, consult a physician.
Skin: Immediately remove soaked or contaminated clothing. Wash skin thoroughly with soap and water. Launder all contaminated clothing before reuse. If skin irritation or rash develops obtain medical assistance.
Ingestion: Product is practically non-toxic. Do not induce vomiting. Obtain emergency medical attention.
Inhalation: Not likely to occur except as a mist. Move to fresh air and provide oxygen if necessary. Obtain emergency medical attention.

Section 7   Personal Protection/ Exposure Controls

Engineering Controls: Use adequate ventilation to keep oil mists of this material applicable standards.
Respiratory Protection: Not required if adequate ventilation. If occupational exposure limits are exceeded wear NIOSH approved apparatus.
Skin Protection: Avoid prolonged and/or repeated skin contact. If prolonged contact cannot be avoided, wear protective impervious gloves and clothing/ Acceptable materials for gloves are polyvinyl chloride;neoprene;polyvinyl alcohol; nitrile;vitron.
Eye Protection: Glasses or goggles. Have suitable eye wash water available.
Other/General Protection: If there is a likelihood of splashing, an oil resistant clothing should be worn. Never wear oil soaked clothing. Launder or dry clean before wearing. Discard oil soaked shoes.

Section 8   Handling and Storage

Handling and Storage Precautions: Keep away from flames, sparks or hot surfaces. Never use a torch to cut or weld on or near container. Empty containers can contain explosive vapors. NFPA Class IIIB storage.
Do not allow product to freeze. IF product freezes allow product to thaw completely prior to use.
Work/Hygienic Practices: Wash thoroughly after handling. Do not use gasoline, solvents, kerosene, or harsh abrasive skin cleaners for washing exposed skin areas. Take a showea after work if general contact occurs. Remove oil-sorked clothing and launder before reuse. Launder or discard contaminated shoes and leather gloves.

Section 9   Accidental Release Measures

- Eliminate ignition sources.
- Absorb spillage with inert material/
- Contain spill and keep from entering waterways or sewers.
- Advise EPA/state agency if required/
- Use personal protective equipment.
- Shovel, sweep or vacuum spill.

Section 10   Toxicological Information

Acute Studies: Tests on similar materials show a low order of acute oral and dermal toxicity.
Eye Effects: Minimal irritation on contact.
Skin Effects: Practically non-toxic if absorbed. May cause mild irritation with prolonged and repeated contact.
Acute Oral Effects: Tests on similar materials indicate low order of acute oral toxicity.
Acute inhalation Effects: Low acute toxicity expected on inhalation.

This product is not listed as a carcinogenic or a potential carcinogen by the National Toxicology Program, by the I.A.R.C. monographs or by OSHA.

Section 11   Stability and Reactivity

Stability: Stable   **Conditions to avoid:** Sources of ignition.   **Incompatibility:** Strong oxidizing or reducing agents.
Decomposition products: Oxides of Carbon, Hydrogen and Nitrogen.   **Hazardous Polymerization:** Will not occur.

Section 12   Ecological Information

No Data available

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Section 13   Disposal Considerations

Follow federal, state and local regulations. Not a RCRA hazardous waste if uncontaminated. If "used" RCRA criteria must be determined. Do no flush into drain/storm sewer use an authorized disposal service. If permitted incineration may be practical. Recommend recycling.

Section 14   Transportation Information

Proper shipping Name: Detergents N.O.S.
Sipping Class: 55
Dot Identification Number: N/A
Dot Shipping Label: Not regulated by DOT.

Section 15   Regulatory Status

U.S. Federal Regulatory Information:
SARA 302 Threshold Planning Quantity: N/A   SARA 304 Reportable Quantity: N/A
SARA 311 Categories:

Acute Health Effects:	None
Chronic Health Effects:	None
Fire Hazard:	No
Sudden Release of Pressure Hazard:	No
Reactivity Hazard:	No

EPA/TSCA Inventory: The components of this product are listed on the EPA/TSCA inventory of chemicals.
EPA Hazard Classification Code: Not applicable
CERCLA: No chemicals in this product are subject to the reporting requirements of CERCLA.
SARA Title III- Section 313 Supplier Notification: No Chemicals in this product exceed the DE Minimus reporting level established by SARA Title III, Section 313 and 40 CFR 372.
WHMIS Classification: Not controlled.

Section 16   Other Information

NFPA Hazard Rating:

Health:	1	Slight
Flammability:	0	Negligible
Reactivity:	0	Negligible

Supersedes MSDS Dated: December 23, 1993
*Threshold Limit Value/Personal Exposure Limit
N/A=Not Applicable
N/E=Not Established

Disclaimer of Express or Implied Warranties

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