

AD-A132 965

DESIGN CONSIDERATIONS FOR GUN PROPELLANT CLIMATIC
STORAGE CHAMBERS(U) WEAPONS SYSTEMS RESEARCH LAB
ADELAIDE (AUSTRALIA) M R GRIVELL ET AL. NOV 82

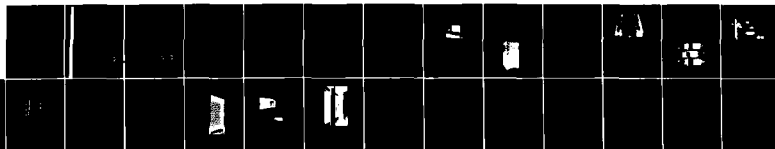
1/1

UNCLASSIFIED

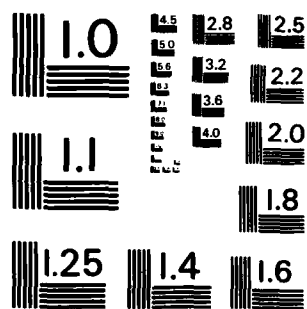
WSRL-0295-TR

F/G 19/1

NL



END
DATE
FILMED
10-83
DT 6



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

WSRL-0295-TR

12

AR-003-080



DEPARTMENT OF DEFENCE

DEFENCE SCIENCE AND TECHNOLOGY ORGANISATION

WEAPONS SYSTEMS RESEARCH LABORATORY

DEFENCE RESEARCH CENTRE SALISBURY
SOUTH AUSTRALIA

TECHNICAL REPORT

WSRL-0295-TR

DESIGN CONSIDERATIONS FOR GUN PROPELLANT
CLIMATIC STORAGE CHAMBERS

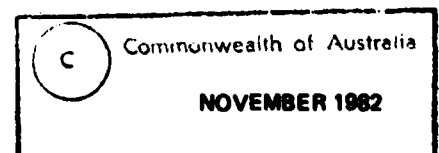
M.R. GRIVELL and A.R. RYE

DTIC FILE COPY

DTIC
ELECTE
SEP 27 1983
S B

Approved for Public Release

COPY No. 2



83 09 26 003

UNCLASSIFIED

DEPARTMENT OF DEFENCE

AR-003-080

DEFENCE SCIENCE AND TECHNOLOGY ORGANISATION

WEAPONS SYSTEMS RESEARCH LABOARTORY



TECHNICAL REPORT

WSRL-0295-TR

DESIGN CONSIDERATIONS FOR GUN
PROPELLANT CLIMATIC STORAGE CHAMBERS

M.R. Grivell and A.R. Rye

S U M M A R Y

→ The transfer of responsibility for gun propellant climatic storage and surveillance from MRL to WSRL required the design and construction of new climatic storage chambers. Various design options were considered; the most suitable used direct electric heating with comprehensive temperature monitoring and controlling circuitry and was constructed as a prototype. Experience gained in this exercise was used in the final design now installed and operating at WSRL.←



DTIC
ELECTE
SEP 27 1983
B

POSTAL ADDRESS: Director, Weapons Systems Research Laboratory,
Box 2151, GPO, Adelaide, South Australia, 5001.

UNCLASSIFIED

TABLE OF CONTENTS

	Page
1. INTRODUCTION	1
2. PRINCIPAL CLIMATIC CHAMBER REQUIREMENTS	1
2.1 Thermal environment	1
2.2 Safety	1
3. EARLY DESIGN STUDIES	2
3.1 Circulating hot water system	2
3.2 Forced air system	2
3.3 Direct electric heating	2
4. EARLY EXPERIMENTS	3
5. WSRL PROTOTYPE	3
5.1 Power source	3
5.2 Insulation	4
5.3 Chamber structure	4
5.4 Direct electrical heating element	5
6. TEMPERATURE CONTROL	6
6.1 Power requirements and thermal monitors	6
6.2 Temperature controller	10
6.3 Over-temperature control	11
6.4 Checks on control circuits	12
7. ASSEMBLY AND PERFORMANCE	12
8. CONCLUSIONS	14
9. ACKNOWLEDGEMENTS	15
REFERENCES	16

LIST OF FIGURES

1. Laboratory test chamber	3
2. Climatic chamber core structure	4
3. Schematic diagram of thermal element	5
4. Prototype thermal element	6
5. Power control circuit diagram	7
6. Power control module	7
7. Temperature control module	8
8. Thermistor (Type GT52C) resistance-temperature characteristic	9
9. Front plates of power and temperature controller boards	10
10. Schematic diagram of temperature control circuit	11
11. Assembled prototype chamber	13
12. Front view of assembled prototype	14
13. Final chamber design	15



Accession For	
NTIS GRA&I	☒
DTIC TAB	☐
Unannounced	☐
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A	

1. INTRODUCTION

Propellants made from nitrocellulose are inherently unstable. One of the consequences of this instability is the liberation of oxides of nitrogen into the propellant matrix. These oxides arise from the thermally-induced dissociation of aliphatic nitrate ester bonds. This reaction is autocatalytic in nature, so the useful life of such propellants can be substantially increased by incorporating chemical compounds which remove the nitrogen oxides by chemical reaction. These compounds, called stabilizers, include diphenylamine, ethyl centralite (2,2'-diethylurea) and p-nitro-N-methylaniline. The chemical reactions associated with stabilizer action are discussed in references 1, 2 and 3.

Among the techniques used to estimate the useful service life of a gun propellant is its storage at elevated temperatures with periodical estimation of residual stabilizer content. Calculations can then be made, based on the accelerated degradation of propellants at high temperatures, which allow limits to be set to the service life. A technique which has gained acceptance in many countries requires storage of gun propellants in glass tubes at a constant temperature of 49°C, with analysis of remaining stabilizer at specific intervals(ref.4). This test was adopted about thirty years ago by Australia and was set up and carried out by Materials Research Laboratories(MRL). During the late 1970's, however, the responsibility for these tests was transferred from MRL to Weapons Systems Research Laboratory (WSRL) and this required the 49°C climatic storage chambers to be relocated at WSRL. The MRL chambers were not transportable because of deterioration and so the opportunity was taken to design and construct chambers at WSRL incorporating modern techniques and materials. Prior to the transfer of responsibility of this task, MRL had carried out some preliminary analysis which was utilised and expanded. This report details the design considerations and ultimate construction of the chambers.

2. PRINCIPAL CLIMATIC CHAMBER REQUIREMENTS

2.1 Thermal environment

The main purpose in the construction of the chambers was to maintain a stable thermal environment for gun propellants stored in glass tubes. The specification calls for temperature control in the range of $49 \pm 3^\circ\text{C}$ but it was felt that better precision was desirable. The goal was to achieve a stable target temperature of 49°C with differentials throughout the chamber of less than $\pm 1.0^\circ\text{C}$. Associated with this requirement was a need for optimum thermal insulation and a high heat capacity, the former to minimise energy requirements and the combination to reduce rate of temperature change in the event of power interruption.

2.2 Safety

The intended use of these chambers at full capacity involves the storage of large quantities of inflammable gun propellants and therefore the highest consideration needed to be given to all aspects of safety. DRCS Safety Section was involved in discussions at all stages of the design evolution. Opinions were also sought from other DRCS personnel with a background in safety matters.

3. EARLY DESIGN STUDIES

The following design options were considered by MRL(ref.5) during the early 1970's.

3.1 Circulating hot water system

A circulating hot water system requires the construction of a climatic chamber with a conducting water jacket, supplied from an external hot water source. The advantages of such a system are:

- (a) temperature control of the inlet water is simple and immediate,
- (b) the heat source is remote from the chambers,
- (c) a 'fail-safe' design to prevent overheating can be readily achieved.

The disadvantages of the circulating hot water concept are:

- (a) adequate thermal contact between the jacket and the external surface of the chamber proper requires very careful design of the manifolding,
- (b) it is very difficult to guard against the existence of undesirable thermal gradients in the chamber,
- (c) water leakage could damage the propellant samples.

3.2 Forced air system

A ducted fan-forced hot air design has most of the characteristics of a circulated-water system except that leaks are not so crucial. An additional advantage is that the heated air could be circulated freely through a 'honeycomb' of propellant tubes, which could lead to more even temperature conditions. However, the proper siting of temperature monitors and design of control circuitry could be quite complex. Also, the construction of inlet manifolds would require careful attention to ensure that proper distribution of the airflow took place.

3.3 Direct electric heating

Initially, safety reservations precluded consideration of the inclusion of electrically-powered elements within the climatic chambers. However, it soon became evident that such a concept had the potential to overcome many of the design and control problems associated with the use of hot air or water.

The advantages of electric heating are:

- (a) excellent thermal contact
- (b) potential for low thermal gradients
- (c) straightforward monitoring and control requirements
- (d) easy maintenance

Problems associated with this technique include the potential for arcing and its inherent hazards.

4. EARLY EXPERIMENTS

The advantages of direct electric heating were considered to be very attractive so a small laboratory test chamber (figure 1) was constructed at MRL. It was a 30 cm cube fabricated using 12 mm thick aluminium plate. Two hundred turns of nichrome wire of appropriate resistance were wound around the outside. The box was then encased in 37 mm thick foamed polystyrene. A number of thermocouples were placed on the six internal surfaces and within the chamber.



Figure 1. Laboratory test chamber

Heat-loss calculations for this test chamber were carried out using the conventional thermal conduction equation:

$$Q.x = k.A.t.\Delta T \quad (1)$$

Where Q = heat transferred from inner surface to outer surface (J)

x = insulation thickness (m)

k = specific conductivity of insulation ($J.m^{-1}.s^{-1}.^{\circ}C^{-1}$)

A = surface area (m^2)

t = time (s)

ΔT = temperature gradient ($^{\circ}C$)

The power consumption of the test chamber element agreed well with calculations based on equation 1. Thermal gradients were small, and long-term temperature stability (after equilibration) was excellent.

5. WSRL PROTOTYPE

The construction of the full-sized WSRL prototype chamber was based on experience gained with the laboratory test chamber. First, a number of issues relating to the components of the facility had to be resolved.

5.1 Power source

The original intent was that the elements would be heated by a low-voltage d.c. current drawn from a continuously-charged bank of nickel-cadmium batteries. As the design evolved, however, it became clear that a stepped-down mains a.c. supply was perfectly acceptable. This allowed the

selection of a simple motor-driven generator as a back-up power source.

5.2 Insulation

The insulation material chosen was a polyisocyanurate foam known commercially as 'Isothex' or 'Hexafoam'. This insulant has high strength and rigidity, allowing it to be lightly supported in the framework. In addition, it has very low thermal conductivity, and high resistance to combustion. It has an oxygen index of 30% and will not burn in air.

5.3 Chamber structure

Careful attention was given to the basic requirements of the chamber 'core'. In essence, these are:

- (a) minimum weight, consistent with structural strength
- (b) free airflow around tubes of propellant
- (c) provision for installation of electric elements
- (d) minimisation of protrusion of structural members through the insulation material.

The core design eventually selected is illustrated in figure 2. Each core is 1860 mm high, 1015 mm deep, and 850 mm wide.

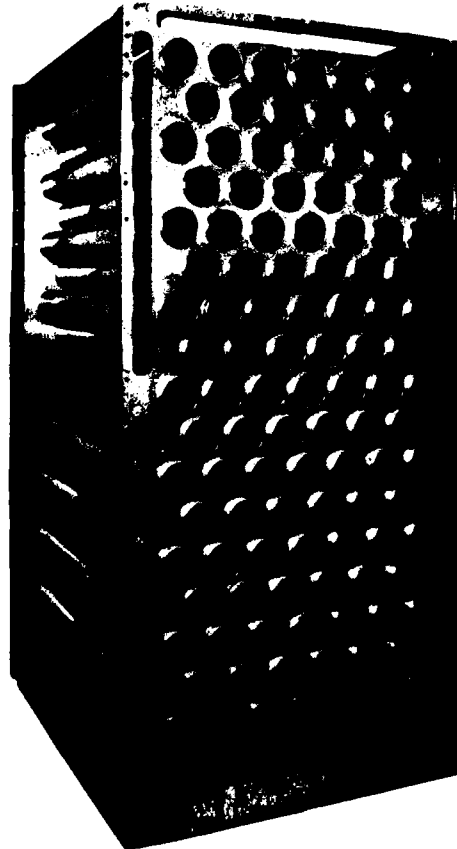


Figure 2. Climatic chamber core structure

This design incorporates 111 thin-walled aluminium alloy tubes arranged in a 'honeycomb' array which are installed between holes in the front and back plates. The gun propellants, in stoppered glass tubes, are inserted in these receptacles. Six slots (two on each vertical side, one each on top and bottom surfaces) and guide rails are included to allow easy insertion and removal of element plates (see Section 5.4). A typical climatic chamber consists of three of these basic cores, separated by and clad with foam insulation.

5.4 Direct electrical heating element

Figure 3 is a schematic diagram of one of the heating elements. Each of these is a monolithic aluminium alloy plate which is cast with an integral 'Pyrotanax' heating element. This element is laid out within the plate in serpentine fashion, giving even thermal coverage to the whole surface of the plate. Each plate contains two monitoring devices; a sensor which is connected to the controlling circuitry, and an over-temperature safety cut-out.

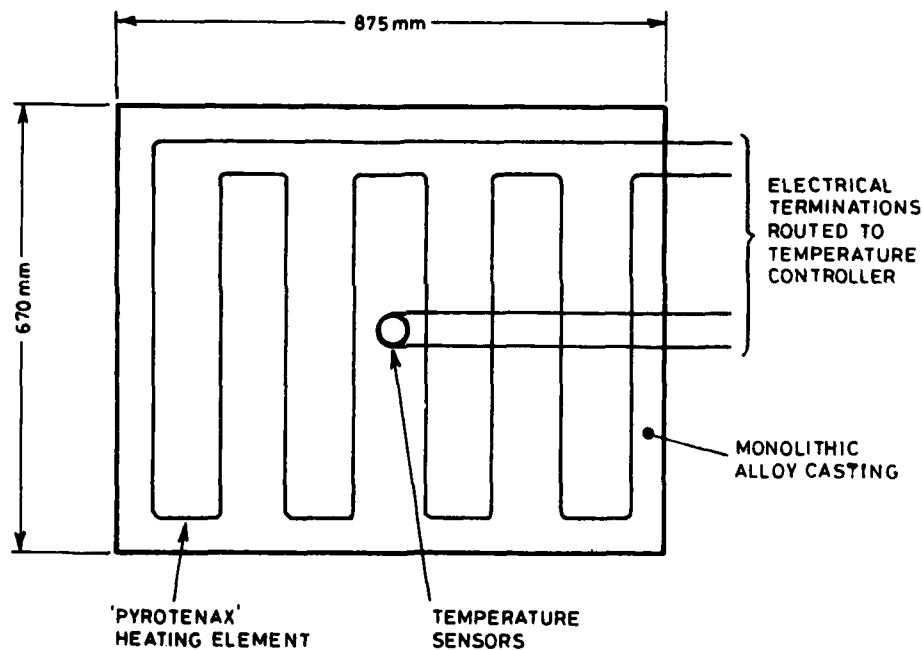


Figure 3. Schematic diagram of thermal element

Figure 4 is a photograph of a prototype element which has certain parts of the design exposed for clarity.

This photograph is of special interest as it shows quite clearly the positions of the temperature sensors and the manner in which connections to the 'Pyrotanax' element are made. All electrical terminations are made at a shielded lockable connector.



Figure 4. Prototype thermal element

6. TEMPERATURE CONTROL

6.1 Power requirements and thermal monitors

Power to each chamber is supplied by a 415V/110V, 2.64 kVA 50Hz three phase transformer that is connected 'delta to star'. Each phase of the transformer supplies power to two heater plates. Each plate is powered through a triac and temperature control circuit as shown in figure 5. Figure 6 is a photograph of an assembled power control module.

The temperature control device (figure 7) depends for its operation on two thermistors mounted centrally in the heater plate. Each thermistor (ITT type GT52C) is a thermally-sensitive resistance bead suspended in a glass pellet mounted in a metal can having a resistance-temperature characteristic as shown in figure 8.

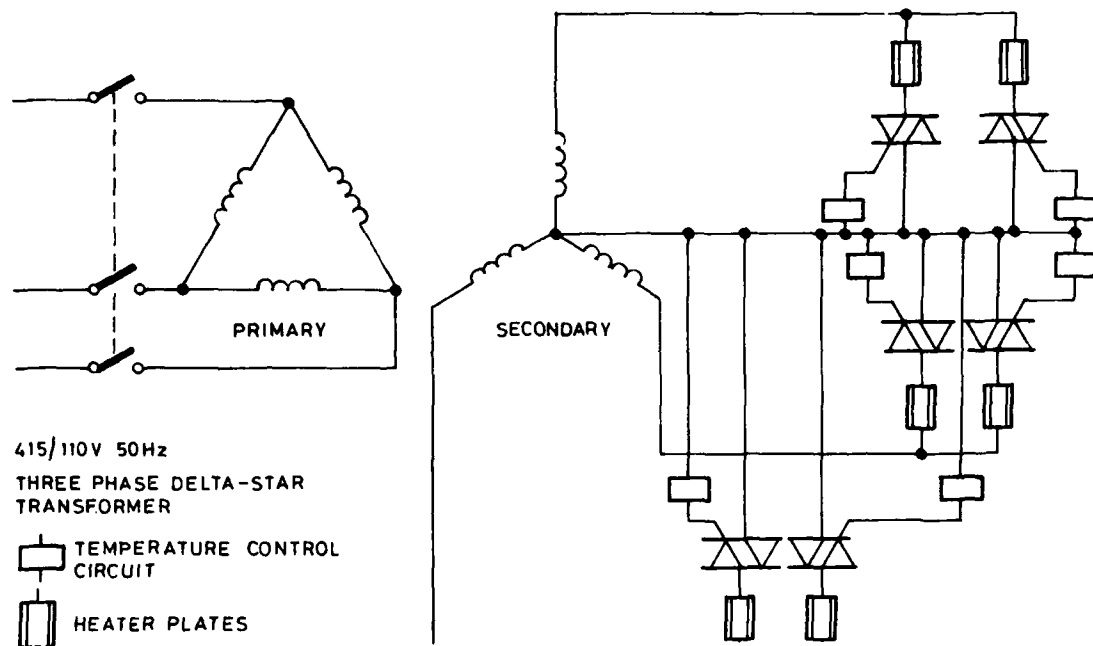


Figure 5. Power control circuit diagram

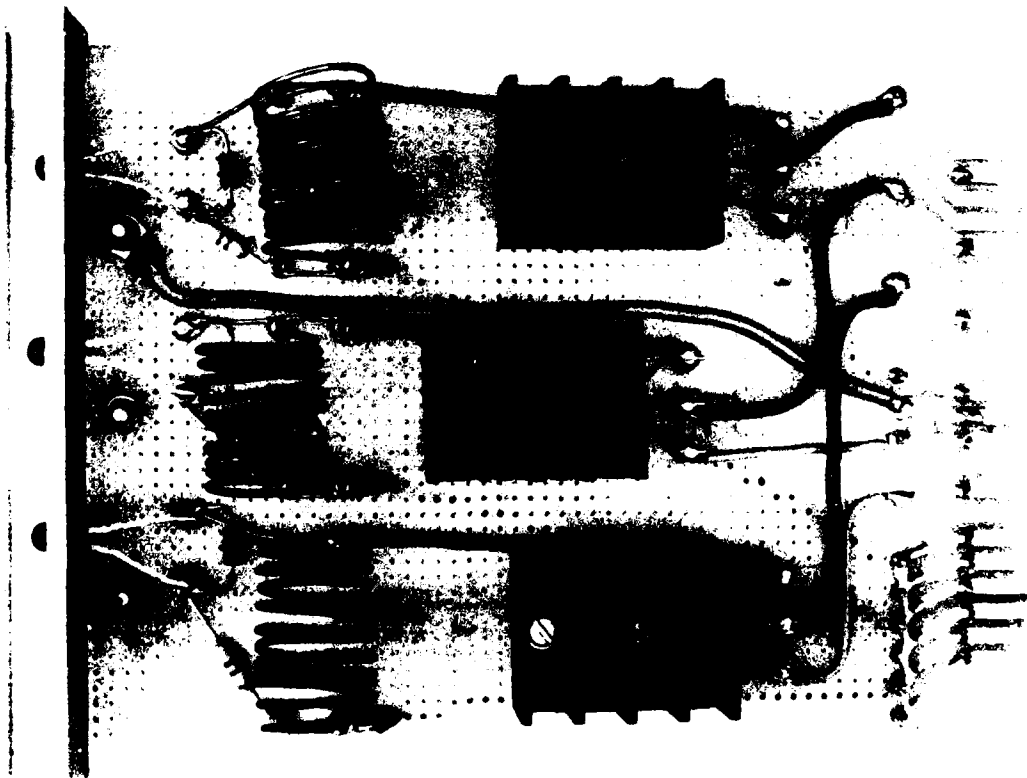


Figure 6. Power control module

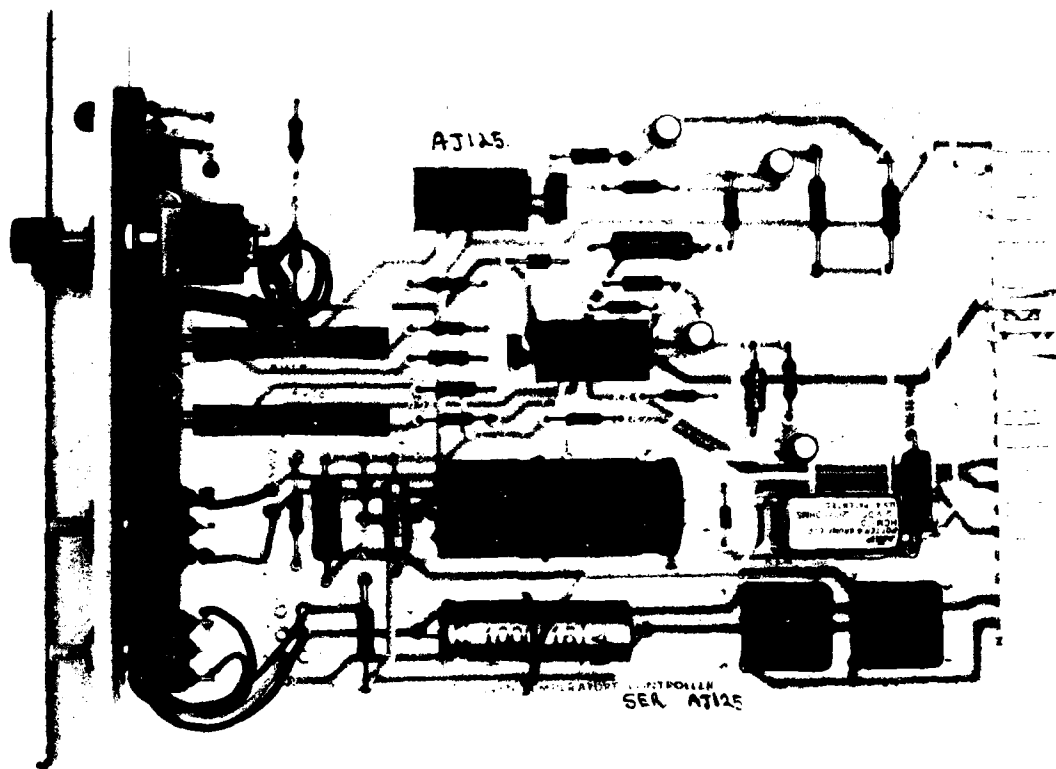


Figure 7. Temperature control module

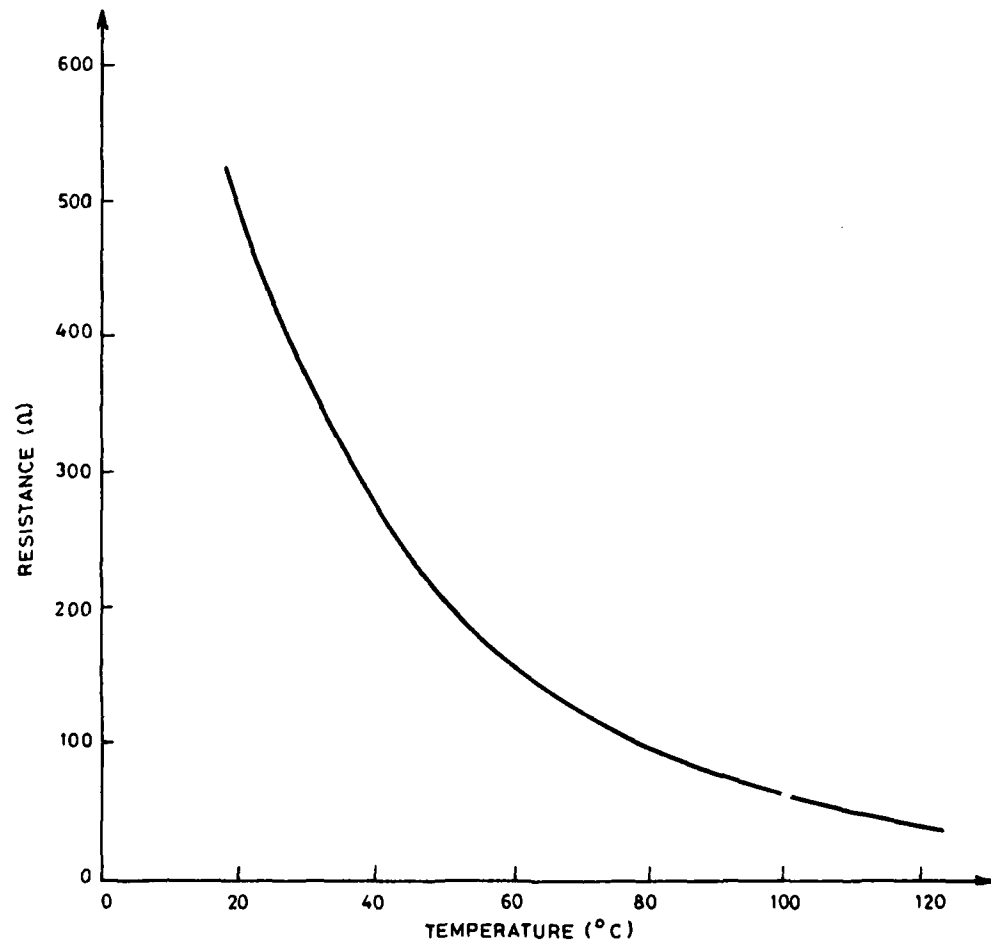


Figure 8. Thermistor (Type GT52C) resistance-temperature characteristic

One of the thermistors is the sensor for the temperature control circuit and the other is the sensing element for the over-temperature control circuit - a safety feature to prevent overheating of the heater plate if a fault occurs. This device monitors the temperature of the heater plate and isolates the power from it if a preset over-temperature condition occurs. An indication that an over-temperature condition exists is given by a LED mounted on the front plate of the temperature controller board (figure 9).

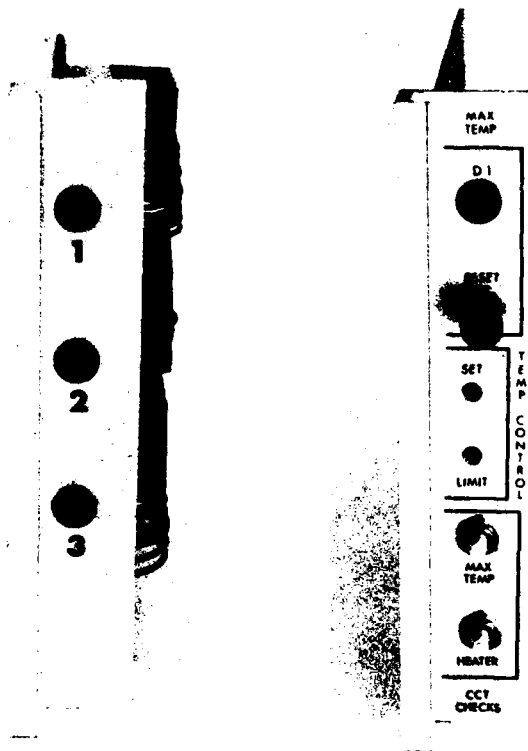


Figure 9. Front plates of power and temperature controller boards

6.2 Temperature controller

A schematic circuit diagram of the temperature controller is shown in figure 10. Full details, including components, are given in reference 6.

The full wave rectifier output voltage of bridge rectifier network V9 is capacitively filtered by C2 and the resistance-zener diode combination provides a regulated voltage for the bridge network R3, R26, R4, R21, R17 and R22. R17 is a 10 k Ω potentiometer which sets the desired temperature for the heater plate and R26 is the thermistor which is mounted in the centre of the heater plate.

At power-up, the heater plate will be at ambient temperature and below the set temperature (49°C). The resistance of the thermistor will be high and so the voltage at pin 4 of the voltage comparator N1 will be more positive than the set temperature voltage at pin 3 and the output voltage of N1 at pin 9 will be low, resulting in the transistor V4 being turned off and the transistor emitter-follower V5 being turned on. The emitter voltage of V5 is fed via the normally closed relay contact RLA/2 to the gate of the triac, and, as the emitter voltage of V5 is high, the triac conducts on each half cycle of the 110V a.c. input supplying power to the heater plate, and the plate begins to heat.

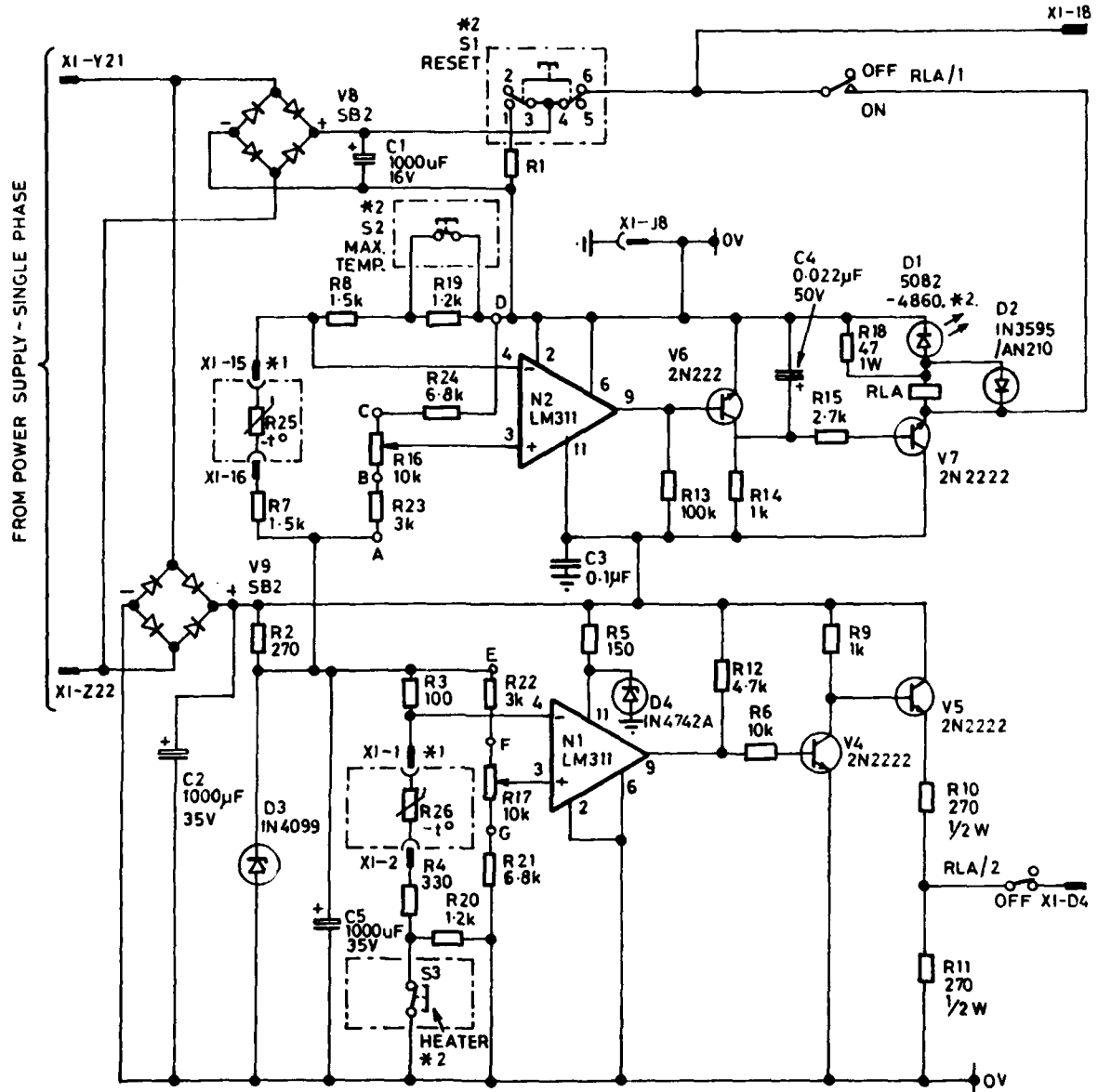


Figure 10. Schematic diagram of temperature control circuit

When the temperature of the heater plate reaches the preset temperature, the resistance of the thermistor reduces to a level where the voltage at pin 4 is below the voltage at pin 3 and the output voltage at pin 9 of N1 switches from a low value to a high value causing transistor V4 to turn on and transistor V5 to turn off. The gate voltage of the triac is now too low for conduction of the triac to take place and heating of the plate ceases. When the triac is conducting, the appropriate LED mounted on the front panel of the triac card (figure 9) indicates that the particular plate is being heated.

6.3 Over-temperature control

The bridge network R7, R25, R8, R24, R16 and R23 is supplied by the regulated voltage of zener diode D3, and potentiometer R16 sets the temperature at which the over-temperature circuit is to operate. At temperatures below the preset temperature, the resistance of thermistor R25

is high and the voltage at pin 4 of the voltage comparator N2 is negative with respect to the preset voltage on pin 3 and the output voltage of N2 at pin 9 is high causing transistor V6 to be turned on and transistor V7 to be turned off. As the temperature of the heater plate rises, the resistance of R25 falls and the voltage on pin 4 of N2 becomes more positive. If a fault in the temperature control circuit occurs and the temperature of the heater plate reaches its preset value the voltage on pin 4 rises slightly above the preset voltage on pin 3 and the output on pin 9 rapidly falls to a low value. This causes transistor V6 to switch off and transistor V7 to turn on operating relay RLA and LED D1. With RLA operated, the normally open contact RLA/1 closes and voltage from the full wave rectifier bridge network V8 is supplied through the reset switch S1 and the self locking closed relay contact RLA/1 to the relay coil causing it to remain in the operated condition. At the same time, the normally closed contact RLA/2 opens removing voltage from the gate of the triac preventing any further heating of the heater plate. This condition continues until the fault has been removed and/or the reset switch S1 has been activated.

The LED D1 indicates that an over-temperature condition has occurred.

6.4 Checks on control circuits

Appropriate test circuits have been incorporated in the equipment to ascertain its serviceability on a day-to-day basis. The temperature control circuit board includes:

(a) Heater plate controller

To check the operation of the heater plate controller, momentary action of switch S3 mounted on the front panel (see figure 9) and marked 'HEATER' is required. Operation of this switch introduces a resistance R20 into the branch of the comparator bridge network containing the thermistor R26, and the voltage on pin 4 of N1 falls below the preset voltage on pin 3. This causes the triac to conduct on each half sine wave of the supply voltage and this is indicated by the LED mounted on the front panel of the temperature controller.

(b) Over-temperature controller

To check the over-temperature controller, activation of switch S2 mounted on the front panel, and marked 'MAX TEMP', is required. Operation of this switch introduces a resistance R19 into the branch of the comparator bridge network containing R7, R25 and R8 and causes the voltage on pin 4 of N2 to increase slightly above the preset voltage on pin 3. The circuit then operates as if it had detected an over-temperature condition and this is indicated by the LED mounted on the front panel of the temperature control card. Operation of the reset switch S1 mounted on the front panel, removes the voltage from the relay coil RLA allowing the circuit to return to its original state.

7. ASSEMBLY AND PERFORMANCE

Test-bench trials of individual heater plates with interim-design temperature control circuits displayed excellent thermal characteristics. Individual insulated plates displayed a variation in surface temperature of $\pm 1.5^{\circ}\text{C}$ when set for temperatures between $40\text{--}75^{\circ}\text{C}$. These results were so encouraging it was decided to manufacture a full-size operating climatic chamber.

A bank of three cores, each as shown in figure 2, was assembled into a steel framework with insulation fitted into the interstices. The heating plates and

associated wiring were installed. A photograph of the prototype at this stage of assembly is shown in figure 11. The wooden vent plugs seen in the photograph were used to simulate the effect of sample tubes.

Each chamber was clad in thin alloy sheet and the front was closed with twelve drawer-type insulated doors secured by magnetic latches. This aspect is illustrated in figure 12.

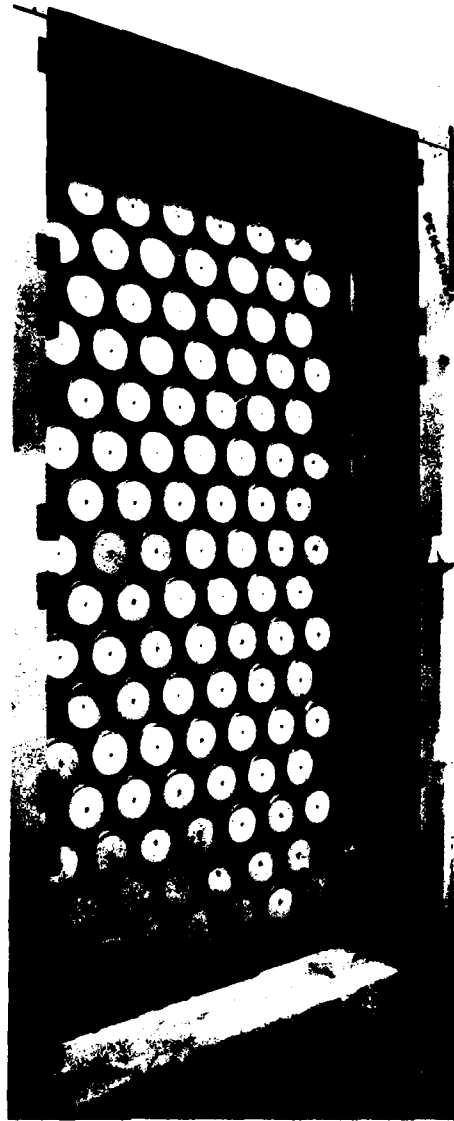


Figure 11. Assembled prototype chamber

Twelve thermocouples were mounted at various points within the central chamber of a triple-chamber assembly. Three other sensors were placed externally to monitor surface temperatures and ambient conditions. The chamber achieved operating temperature within ninety minutes of power-up, and over a three-day test period all internal thermocouples displayed individual variations of less than 0.5°C . A consistent thermal pattern emerged, as expected, with a thermal gradient extending from the upper region of the chamber to a cooler zone at the base. This temperature gradient was never greater than 2°C and usually about 1°C .

The performance of this prototype chamber was perfectly acceptable for routine



Figure 12. Front view of assembled prototype

climatic storage testing of propellants. After some minor attention to design detail, it was brought into service in late 1978.

Two years experience led to a refinement of the design in 1980. Improvements to insulation installation and careful matching of the temperature control circuits to individual thermal elements has resulted in overall temperature gradients of better than $\pm 0.5^{\circ}\text{C}$ being achieved. In addition, the current chambers are fitted with hinged doors with integral insulation as shown in figure 13. This has improved sample accessibility and reduced thermal losses through reduction in the number of seals required.

8. CONCLUSIONS

Direct electric heating has proved to be an efficient and flexible means of providing a stable thermal environment for gun propellants undergoing assessment by the long-term climatic storage procedure. Chambers incorporating this form of heating, controlled by electrical circuits capable of maintaining both a stable temperature and safe operating conditions, have proved to be a significant improvement over earlier designs. Energy consumption at equilibrium is low, and thermal stability is excellent.



Figure 13. Final chamber design

9. ACKNOWLEDGEMENTS

The early experiments which provided the original basis for this work were carried out at Materials Research Laboratory, Maribyrnong. In particular, substantial contributions were made by Mr S. Thomas and Mr D.R. Sadedin.

The authors wish to express their thanks to the personnel of the Engineering Workshops of Advanced Engineering Laboratory for advice and assistance in the manufacture of these chambers, and especially to Mr M. Koldowski of AEL Test Section.

REFERENCES

No.	Author	Title
1	Ball, A.M.	"Solid Propellants - Part One". AMC Pamphlet 706-175, September 1964
2	Mortlock, H.N.	"The Determination of the Safe Life of Explosives". CDSO Conference (Proceedings), Canberra, May 1982
3	Leveneu, L., Seite, P. and Tranchant, J.	"Consommation de Stabilisant et Evaluation de la Stabilite des Poudres (Consumption of Stabiliser and Evaluation of the Stability of Powders)". 3e Symposium International de Balistique, April 1980
4	Kempson, R.M. and Rogasch, P.E.	"The Determination of Diphenylamine and Ethyl Centralite in Propellants: A Survey of methods available and a Comparison of Results between the 'Markham Still' method and the currently used Bromination methods". WSRL-0094-TR, April 1979
5	D.R. Sadedin, Materials Research Laboratory	Unpublished work, 1975
6	Weapons Systems Research Laboratory	"Controller Card - Controlled Temperature Oven". Drawing PD8838, September 1982

DISTRIBUTION

Copy No.

EXTERNAL

In United Kingdom

Defence Science Representative, London	No copy
British Library, Lending Division, Boston Spa, York	1
Mr W.A. Clayden, Royal Armament Research and Development Establishment (RARDE)	2
National leaders TTCP Panels WTP-2 and WTP-4	3 - 4

In United States of America

Counsellor, Defence Science, Washington	No copy
National Technical Information Services, Springfield, Va.	5
Mr J.M. Frankle, US Army Ballistic Research Laboratory	6
National leaders TTCP Panels WTP-2 and WTP-4	7 - 8

In Canada

National leaders TTCP Panels WTP-2 and WTP-4	9 - 10
--	--------

In Federal Republic of Germany

Dr G.A. Schroeder, Ernst Mach Institut (EMI-AFB)	11
Dr F. Volk, Institut für Chemie der Trieb-und Explosivstoffe (ICT)	12

In France

Dr U. Vogel, Institut Franco-Allemand de Recherches de Saint-Louis (ISL)	13
--	----

In Australia

Department of Defence

Chief Defence Scientist	}	14
Deputy Chief Defence Scientist		
Superintendent, Science and Technology Programmes		
Controller, Project and Analytical Studies		
Director, Joint Intelligence Organisation (DSTI)		15
Army Scientific Adviser		16
Navy Scientific Adviser		17

Air Force Scientific Adviser	18
Document Exchange Centre	
Defence Information Services Branch (for microfilming)	19
Document Exchange Centre	
Defence Information Services Branch for:	
United Kingdom, Ministry of Defence	
Defence Research Information Centre (DRIC)	20
United States, Defense Technical Information Center	21 - 32
Canada, Department of National Defence	
Director, Scientific Information Services	33
New Zealand, Ministry of Defence	34
Australian National Library	35
National leaders TTCP Panels WTP-2 and WTP-4	36 - 37
President, Australian Ordnance Council	38
Director, Armaments and Electronic Materiel (Army Office)	39
Army Quality Assurance Division	40 - 41
Director of Naval Ordnance Inspection	42
Inspector of Naval Ordnance, Sydney	43
Inspector of Naval Ordnance, Melbourne	44
Inspector of Naval Ordnance, Adelaide	45
Director General, Army Development (NSO), Russell Offices for ABCA Standardisation Officers	
UK ABCA representative, Canberra	46
US ABCA representative, Canberra	47
Canada ABCA representative, Canberra	48
NZ ABCA representative, Canberra	49
Defence Library, Campbell Park	50
Library, H Block, Victoria Barracks, Melbourne	51
Library, Engineering Development Establishment	52
Library, Aeronautical Research Laboratories	53
Library, Materials Research Laboratories	54
Department of Defence Support	
Assistant Secretary, Industry Development Branch	55

Assistant Secretary, Marketing Branch	56
Assistant Controller (Development), Munitions Supply Division	57
General Manager, Explosives Factory Mulwala	58
General Manager, Explosives Factory Maribyrnong	59
General Manager, Explosives Factory Albion	60
General Manager, Ammunition Factory Footscray	61
General Manager, Munitions Filling Factory St Marys	62
Director, Industry Development, Regional Office, Adelaide	No copy

WITHIN DRCS

Director, Weapons Systems Research Laboratory	63
Superintendent, Propulsion Division	64
Principal Officer, Gun Propulsion Research Group	65
Principal Officer, Rocket Propulsion Research Group	66
Principal Officer, Propulsion Systems Group	67
Principal Officer, Nitrocellulose Propellants Group	68
Principal Officer, Composite Propellants and Explosives Group	69
Dr P.J. Carson, Gun Propulsion Research Group	70
Mr K.H.J. Adams, Gun Propulsion Research Group	71
Mr R.H. Weldon, Gun Propulsion Research Group	72
Mr I.R. Johnston, Gun Propulsion Research Group	73
Mr R.T. Hammond, Gun Propulsion Research Group	74
Mr F.A. Rousseau, Gun Propulsion Research Group	75
D.J. Graham, Gun Propulsion Research Group	76
Dr R.M. Lough, Propulsion Systems Group	77
Dr C.W. Fong, Nitrocellulose Propellants Group	78
Mr P.E. Rogasch, Nitrocellulose Propellants Group	79
Mr R.M. Kempson, Nitrocellulose Propellants Group	80
Mr N.V. Ayres, Nitrocellulose Propellants Group	81
Mr M. Koldowski, AEL Test Section	82
Propulsion Division Library	83 - 84

WSRL-0295-TR

DRCS Library

85 - 86

Authors

87 - 88

Spares

89 - 105

DOCUMENT CONTROL DATA SHEET

Security classification of this page

UNCLASSIFIED

1	DOCUMENT NUMBERS	2	SECURITY CLASSIFICATION
AR Number: AR-003-080		a. Complete Document: Unclassified	
Series Number: WSRL-0295-TR		b. Title in Isolation: Unclassified	
Other Numbers:		c. Summary in Isolation: Unclassified	
3	TITLE		
DESIGN CONSIDERATIONS FOR GUN PROPELLANT CLIMATIC STORAGE CHAMBERS			
4	PERSONAL AUTHOR(S):	5	DOCUMENT DATE:
M.R. Grivell and A.R. Rye		November 1982	
		6	6.1 TOTAL NUMBER OF PAGES 16
		6.2 NUMBER OF REFERENCES: 6	
7	7.1 CORPORATE AUTHOR(S):	8	REFERENCE NUMBERS
Weapons Systems Research Laboratory		a. Task: DEF 91/001	
7.2 DOCUMENT SERIES AND NUMBER		b. Sponsoring Agency:	
Weapons Systems Research Laboratory			
9	COST CODE:		
		384208	
10	IMPRINT (Publishing organisation)	11	COMPUTER PROGRAM(S) (Title(s) and language(s))
Defence Research Centre Salisbury			
12	RELEASE LIMITATIONS (of the document):		
Approved for Public Release			

Security classification of this page:

UNCLASSIFIED

Security classification of this page:

UNCLASSIFIED

13 ANNOUNCEMENT LIMITATIONS (of the information on these pages):

No limitation

14 DESCRIPTORS:

a. EJC Thesaurus
Terms

Design
Gun propellants Construction
Storage
Chambers
Temperature control

b. Non-Thesaurus
Terms

15 COSATI CODES:

19010

16 SUMMARY OR ABSTRACT:

(if this is security classified, the announcement of this report will be similarly classified)

The transfer of responsibility for gun propellant climatic storage and surveillance from MRL to WSRL required the design and construction of new climatic storage chambers. Various design options were considered; the most suitable used direct electric heating with comprehensive temperature monitoring and controlling circuitry and was constructed as a prototype. Experience gained in this exercise was used in the final design now installed and operating at WSRL.

Security classification of this page:

UNCLASSIFIED

"The official documents submitted to the Commission of the European Communities (hereinafter referred to as the Commission) are divided into two categories: 'Business Documents' and 'Business Documents' and 'Business Documents'." The purpose of the other two categories is different, with the other two categories being used for the following purposes:

- Business Documents: Documents submitted for the purpose of the Commission.
- Business Documents: Documents of scientific and technical nature of a government nature intended for the Commission and the Commission's activities in the field.
- Business Documents: Documents submitted for the Commission's information within the EC. They are usually submitted in French and contain the personal name of the author.

DATE
ILME