AD NUMBER
AD508353

CLASSIFICATION CHANGES
TO: unclassified
FROM: confidential

LIMITATION CHANGES
TO:
Approved for public release, distribution unlimited

FROM:
Distribution authorized to U.S. Gov’t. agencies and their contractors; Administrative/Operational Use; OCT 1969. Other requests shall be referred to Air Force Propulsion Lab., Edwards AFB, CA.

AUTHORITY
31 Oct 1981, DoDD 5200.10; AFRPL ltr, 13 Feb 1986

THIS PAGE IS UNCLASSIFIED
THIS REPORT HAS BEEN DELIMITED
AND CLEARED FOR PUBLIC RELEASE
UNDER DOD DIRECTIVE 5200.20 AND
NO RESTRICTIONS ARE IMPOSED UPON
ITS USE AND DISCLOSURE.

DISTRIBUTION STATEMENT A

APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED.
SECURITY MARKING

The classified or limited status of this report applies to each page, unless otherwise marked. Separate page printouts MUST be marked accordingly.

THIS DOCUMENT CONTAINS INFORMATION AFFECTING THE NATIONAL DEFENSE OF THE UNITED STATES WITHIN THE MEANING OF THE ESPIONAGE LAWS, TITLE 18, U.S.C., SECTIONS 793 AND 794. THE TRANSMISSION OR THE REVELATION OF ITS CONTENTS IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED BY LAW.

NOTICE: When government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related government procurement operation, the U.S. Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.
THE SYNTHESIS OF NEW IONIC INTERHALOGEN OXIDIZERS

F. Q. ROBERTO

OCTOBER 1969

TECHNICAL REPORT AFRPL-TR-69-219

IN ADDITION TO SECURITY REQUIREMENTS WHICH MUST BE MET, THIS DOCUMENT IS SUBJECT TO SPECIAL EXPORT CONTROLS AND EACH TRANSMITTAL TO FOREIGN GOVERNMENTS OR FOREIGN NATIONALS MAY BE MADE ONLY WITH PRIOR APPROVAL OF AFRPL (RPOR-STINFO), EDWARDS, CALIFORNIA 93523.

AIR FORCE ROCKET PROPULSION LABORATORY
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
EDWARDS, CALIFORNIA

THIS DOCUMENT CONTAINS INFORMATION AFFECTING THE NATIONAL DEFENSE OF THE UNITED STATES WITHIN THE MEANING OF THE ESPIONAGE LAWS, TITLE 18, U.S.C., SECTION 793 AND 794, THE TRANSMISSION OF WHICH IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED BY LAW.

CONFIDENTIAL

DOWNGRADED AT 3 YEAR INTERVALS; DECLASSIFIED AFTER 12 YEARS. DOD DIR 8500.10
CONFDIDENTIAL

NOTICES

When U.S. Government drawings, specifications, or other data are used for any purpose other than a definitely related Government procurement operation, the Government thereby incurs no responsibility nor any obligation whatsoever, and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise, or in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

CONFIDENTIAL

(This page is unclassified)
THE SYNTHESIS OF NEW IONIC INTERHALOGEN OXIDIZERS (U)

Francisco Q. Roberto

In addition to security requirements which must be met, this document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of AFRPL (RPOR-STINFO), Edwards, California 93523.

DOWNGRADED AT 3 YEAR INTERVALS;
DECLASIFIED AFTER 12 YEARS.
DOD DIR 5200.10
FOREWORD

(U) This is a phase report of work conducted at the Air Force Rocket Propulsion Laboratory to determine the feasibility of producing interhalogen high-energy liquid oxidizers. This work was accomplished under Project 314801ACL during the period of July 1968 through July 1969 by Dr. Francisco Q. Roberto, Task Scientist. The author wishes to acknowledge the valuable technical discussions and support furnished by Dr. Claude Merrill, Project Scientist; Dr. Charles Bock for X-ray diffraction work and to Mr. John H. Leahy for the analysis of this hazardous and very reactive material. The author also wishes to acknowledge Dr. George Begun, Oak Ridge National Laboratory for running the Raman spectral study.

(U) This report has been reviewed and approved.

NORMAN J. VANDER HYDE
Chief, Solid Propellant Branch
Propellant Division
Air Force Rocket Propulsion Laboratory
The synthesis of hexafluorochloronium (VII) hexafluoroplatinate (V), $\text{ClF}_6^+\text{PtF}_6^-$ , from the reaction of chlorine pentafluoride and platinum hexafluoride is described as an oxidation-reduction reaction. This has been confirmed by elemental analyses, infrared and Raman spectroscopy, X-ray powder diffraction and displacement reaction with trifluorochlorine oxide. This is the first example of a perfluorinated heptavalent chlorine cation. The compound, $\text{ClF}_6^+\text{PtF}_6^-$ , has been indexed as having a cubic structure based on preliminary X-ray powder pattern.
TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>(U) I INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>(U) II EXPERIMENTAL PROCEDURES</td>
<td>2</td>
</tr>
<tr>
<td>A. (U) Equipment</td>
<td>2</td>
</tr>
<tr>
<td>B. (U) Materials</td>
<td>2</td>
</tr>
<tr>
<td>C. (U) Analysis</td>
<td>3</td>
</tr>
<tr>
<td>D. (C) Reaction of Platinum Hexafluoride with Chlorine Pentafluoride</td>
<td>4</td>
</tr>
<tr>
<td>E. (C) Reaction with ClF₃O</td>
<td>5</td>
</tr>
<tr>
<td>(U) III RESULTS AND DISCUSSION</td>
<td>7</td>
</tr>
<tr>
<td>(U) BIBLIOGRAPHY</td>
<td>12</td>
</tr>
<tr>
<td>(U) DISTRIBUTION</td>
<td>15</td>
</tr>
<tr>
<td>(U) FORM 1473</td>
<td>21</td>
</tr>
</tbody>
</table>

ILLUSTRATIONS

<table>
<thead>
<tr>
<th>Figure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>(C) 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Infrared Spectrum of ClF₆⁺PtF₆⁻ and ClF₄⁺PtF₆⁻</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>(C) 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>X-Ray Powder Data for ClF₆⁺PtF₆⁻</td>
</tr>
</tbody>
</table>
(U) Reactions of platinum hexafluoride with other oxidizing agents have
been studied by several investigators. (1-6) With chlorine trifluoride,
difluorochloronium (III) hexafluoroplatinate (V) (ClF₂PtF₆), and chlorine
pentafluoride (7) are produced. (6) Gortsema and Toeniskoetter (6) also
attempted to react platinum hexafluoride with chlorine pentafluoride; the
only product observed, in addition to the reactant, was a yellow solid
believed to be ClF₂PtF₆ (it was assumed that it resulted from the
decomposition of chlorine pentafluoride into chlorine trifluoride and subse-
quent reaction of chlorine trifluoride with platinum hexafluoride). Recent
studies of the same reaction have shown that tetrafluorochloronium (V)
hexafluoroplatinate (V) was produced. (8) Other salts of tetrafluorochloro-
nium ion have been reported recently. (9)

(C) Studies in this laboratory of platinum hexafluoride with chlorine
pentafluoride have shown that in an excess of chlorine pentafluoride using
a sapphire reactor, a solid product, believed to be hexafluorochloronium
(VII) hexafluoroplatinate (V) (ClF₆PtF₆), was obtained. The cation ClF₆⁺
has been reported previously. (10, 11) However, most of the evidence was
based on infrared data and more recent studies have disputed its
synthesis. (12) The solid produced in this laboratory is markedly different
from those reported (10-12) and new data are presented for the synthesis of
ClF₆⁺ in this laboratory.
SECTION II
EXPERIMENTAL PROCEDURES

A. EQUIPMENT

(U) The vacuum system used in this work consisted of a nickel manifold constructed from 1/4-inch nickel pipe to which a number of subsystems were attached. These were: (1) a multipurpose line for handling, measuring, and transferring reactants; (2) a line for purifying and storing fluorine; and (3) a similar line for purifying halogen fluorides. All valves (Hoke TM 131 monel diaphragm valves with metal seats) were silver-soldered to the manifold outlets. Pressure measurements were made with the Wallace and Tiernan gage, Model FA 145, accurate to 0.2 torr. Volumes were calibrated using pure helium and nickel bulbs of known volume.

(U) The vacuum system and sapphire reactors were passivated with fluorine at 300° using a heat gun. Passivation was considered complete when pressure at ambient temperature was identical before and after heating to 300°. Before each run, the whole system was passivated with chlorine pentafluoride followed by a final passivation with platinum hexafluoride.

B. MATERIALS

(U) Platinum hexafluoride was obtained from Ozark-Mahoning Company, Tulsa, Oklahoma. The material was further purified by low-temperature distillation according to the procedure described. (1)
The infrared spectrum\(^{(13)}\) and vapor pressure of the pure material agreed well with the published values.

(C) Chlorine pentafluoride and trifluorochlorine oxide, \(\text{ClF}_3\text{O}\),\(^{(12)}\) were obtained from Rocketdyne, a Division of North American Aviation, Canoga Park, California. The material was used without further purification.

C. ANALYSIS

(U) The platinum compounds were transferred into a 50-ml quartz reactor that had been previously weighed in the dry box and purged with dry nitrogen. The reactor was then connected to the vacuum system to remove the nitrogen and reweighed. The sample was frozen at \(-196^\circ\) and 5-10 ml of double-distilled water was transferred to the sample. Immediate reaction was accompanied by a flash when vapor initially came into contact with the sample. The sample was warmed to ambient temperature by removing the liquid nitrogen trap. After half an hour at ambient temperature, the solution was refrozen to \(-196^\circ\) and 5-10 ml of hydrazine was transferred to it. The solution was again warmed to ambient temperature. The platinum solids formed by hydrolysis and reduction were filtered off; they were redissolved with aqua regia to convert the platinum-containing materials to chloroplatinic acid. The solution was diluted with water, reduced with sodium formate,\(^{(14)}\) and the finely divided platinum metal was filtered, dried, and weighed. After additional dilution, aliquots of the stock solution were analyzed for chlorine and fluorine. Chloride ions were determined by anodic chronopotentiotetry using a silver electrode.
Fluoride ion was determined potentiometrically with an Orion fluoride ion electrode. \(^{(15)}\) The above methods were checked with standard samples.

\(^{(U)}\) X-ray diffraction studies were carried out using the powder techniques with samples sealed in 0.3-mm thin-wall quartz capillary tubes. The tubes were previously flamed in a vacuum line to remove moisture. Samples were loaded in a dry box, flushed with dry nitrogen, sealed with Kel-F grease, and placed in a 5.73-cm Debye-Sherrer camera. Measurements were made using copper K\(\alpha_1\) radiation with a nickel filter. Exposure times varied from 1/2 hour to 4 hours. Intensities were estimated visually.

\(^{(U)}\) Infrared spectra were obtained with Beckman IR-5A and Perkin-Elmer 337 spectrophotometers. Gaseous spectra were obtained using a 10-cm nickel cell equipped with silver chloride windows. Spectra were obtained on the solid pressed between chloride windows of the nickel infrared cell. All operations were carried out in a dry box.

D. REACTION OF PLATINUM HEXAFLUORIDE WITH CHLORINE PENTAFLUORIDE

\(^{(C)}\) In a typical reaction, 1.26 mmole (0.390 grams) of platinum hexafluoride, and 3.78 mmole (0.491 grams) of chlorine pentafluoride were condensed at -196° into an evacuated, prepassivated 7-cc sapphire reactor. The reaction mixture was slowly warmed to ambient temperature. The mixture was left exposed to light at 22-23° for a period of 8 days. The reaction was monitored by the disappearance of PtF\(_6\) (red gas). As time progressed, the red-brown solid phase became lighter. After 8 days,
the solid turned to the bright yellow color of the $\text{CIF}_x\text{PtF}_6$ salt.

The reactor was cooled to -196°C and found to contain no noncondensable gas. The gaseous mixture was found to contain only $\text{CIF}_5$. The excess $\text{CIF}_5$ was removed under vacuum giving a bright orange-yellow solid with no vapor pressure at room temperature. The weight of the solid product was 0.489 grams. The material was analyzed according to the procedure described.

(C) Anal. Calcd. for $\text{CIF}_6\text{PtF}_6$: Pt, 42.56; F, 49.7; Cl, 7.73.

Found: Pt, 42.7; F, 47.2; Cl, 5.2.

(C) The infrared spectrum of the yellow solid was prepared in the dry box by pressing it between silver chloride windows. This is shown in Figure 1. The X-ray powder pattern of the solid is given in Table I.

E. REACTION WITH $\text{CIF}_3\text{O}$

(C) In order to further characterize the $\text{CIF}_x\text{PtF}_6$, excess $\text{CIF}_3\text{O}$ was condensed on top of the solid of $\text{CIF}_x\text{PtF}_6$ at -196°C. The reactor was gradually warmed to -85°C using trike-liquid nitrogen slush. There was very little evidence of reaction at this temperature for 30 minutes. At -75°C, there was some reaction and the only volatile product found was $\text{CIF}_5$ and a trace of $\text{ClFO}_2$. This reaction continued up to -35°C producing more $\text{CIF}_5$. The total noncondensable (-196°C) was 5 mm after about 2 1/2 hours. The reaction was left overnight starting at -35°C and gradually warming to room temperature. The 40 millimeters of noncondensable at -196°C was identified (by mass spectral analysis and reaction
with mercury) as fluorine. The ClF$_5$ formed was transferred and weighed by pumping on the reactor at -85°C. After all the volatile product was removed, the solid was weighed and subjected to infrared analyses. The infrared spectra was identical to the spectra of ClOF$_2$PtF$_6$ (17) previously obtained between the reactions of ClF$_3$O and PtF$_6$.

(7) Based on the weight of fluorine, chlorine pentafluoride and ClF$_2$OpTf$_6$ produced, the ClFxPtF$_6$ was calculated to contain a 50:50 mixture of ClF$_4$PtF$_6$ and ClF$_6$PtF$_6$ within experimental error. These results definitely established the presence of ClF$_6^+$ in the reaction product. The reaction to produce the heptavalent ClF$_6^+$ can be written as:

\[ \text{ClF}_5 + 2 \text{PtF}_6 \longrightarrow \text{ClF}_6\text{PtF}_6 + \text{PtF}_5 \]

In excess ClF$_5$, PtF$_5$ reacts with it to give ClF$_4$PtF$_6$. 

6

CONFIDENTIAL
(C) The solid product obtained in the reaction between platinum hexafluoride and chlorine pentafluoride using a sapphire reactor activated with light is believed to be $\text{CIF}_6\text{PtF}_6$, in accordance with the equation

$$\text{CIF}_5 + 2 \text{PtF}_6 \rightarrow \text{CIF}_6\text{PtF}_6 + \text{PtF}_5$$

In excess $\text{CIF}_5$, the reaction proceeds further to give $\text{CIF}_4\text{PtF}_6$. The overall reaction in excess $\text{CIF}_5$ can be expressed as:

$$\text{XS CIF}_5 + 2 \text{PtF}_6 \rightarrow \text{CIF}_6\text{PtF}_6 + \text{CIF}_4\text{PtF}_6$$

The reaction can be described as an oxidation-reduction where chlorine is oxidized to the heptavalent state forming an ionic solid $\text{CIF}_6^+\text{PtF}_6^-$. However, in an excess $\text{CIF}_5$, $\text{PtF}_5$ is acting as a Lewis acid abstracting a fluoride ion from $\text{ClF}_5$ to give $\text{CIF}_4\text{PtF}_6$.

(C) Further evidence for the synthesis of $\text{CIF}_6\text{PtF}_6$ was obtained from the reaction with trifluorochlorine oxide. The mass balance obtained from the reaction of $\text{CIF}_4\text{PtF}_6$, $\text{CIF}_6\text{PtF}_6$ with $\text{ClF}_3\text{O}$ indicates that $\text{CIF}_4\text{PtF}_6$ reacted with $\text{ClF}_3\text{O}$ at $-75^\circ$ to $-35^\circ$ according to the equation:

$$\text{CIF}_3\text{O} + \text{CIF}_4\text{PtF}_6 \rightarrow \text{CIF}_5 + \text{CIF}_2\text{OPtF}_6$$

Above $-35^\circ$, melting point of $\text{ClF}_3\text{O}$, $\text{CIF}_6\text{PtF}_6$ then reacted with $\text{ClF}_3\text{O}$ in one of two ways:
\[
\text{ClF}_3O + \text{ClF}_4\text{PtF}_6 \rightarrow \text{ClF}_2\text{OPtF}_6 + \text{ClF}_5 + F_2
\]

or

\[
\text{ClF}_3O + \text{ClF}_6\text{PtF}_6 \rightarrow \text{ClF}_2\text{OPtF}_6 + \text{ClF}_7
\]

\[
[\text{ClF}_7] \rightarrow \text{ClF}_5 + F_2
\]

Since the only volatile products observed at ambient temperature were ClF\(_5\) and fluorine, it is implied that ClF\(_7\) formed and is unstable at this temperature or it is catalytically decomposed by ClF\(_2\)OPtF\(_6\). From this study the composition of the mixture was deduced to be a 50:50 mixture of ClF\(_6\)PtF\(_6\) and ClF\(_4\)PtF\(_6\) based on the weight of fluorine, ClF\(_5\) and ClF\(_2\)OPtF\(_6\) produced from the above equation.

(C) The infrared spectrum of solid mixture ClF\(_6\)PtF\(_6\) + ClF\(_4\)PtF\(_6\) pressed between silver chloride plates consists of bands attributed to ClF\(_4\)PtF\(_6\) and bands at 889, 875 and 540 cm\(^{-1}\) assigned to ClF\(_6\)^\(+\) and the peak at 649 cm\(^{-1}\) attributed to the PtF\(_6\)^\(-\) absorption band. The 890, 875 and 540 cm\(^{-1}\) observed in the infrared were absent in the Raman spectrum as expected of an octahedral molecule. Since ClF\(_6\)^\(+\) is isoelectronic with the octahedral, SF\(_6\), some similarity in their spectra is expected, except for slight frequency shifts due to their mass difference. The higher mass of the central atom in ClF\(_6\)^\(+\) compared to SF\(_6\) should cause a shift toward lower frequencies, as is indeed observed for the infrared active bands.
CONFIDENTIAL

Going from SF₆ (940 cm⁻¹, γ₃) to ClF₆⁺ (890 cm⁻¹, γ₃), the shift is 50 cm⁻¹; γ₄ for SF₆ at 615 cm⁻¹ is shifted by 65 cm⁻¹ in ClF₆⁺ (540 cm⁻¹).

These assignments are tentative and require further refinements.

(C) Of the six normal modes of vibration expected of an octahedral ion of the type XY₆⁺, (A₁g + E₉ + 2F₁u + F₂g + F₂u), only two of these modes (2F₁u) will be infrared active and three will be Raman active (A₁g, E₉, and F₂u).

(C) The remaining F₂u mode is inactive in both infrared and Raman spectrum. However, since the octahedral PtF₆⁻ mode of vibrations have not been assigned, it is rather difficult to assign vibrations due to ClF₆⁺ with any certainty. Since the only absorption band that we can assign with any degree of certainty to PtF₆⁻ is the absorption band at 645 cm⁻¹, the other absorption bands, in addition to 890, 875 and 540, at 521 and 313 cm⁻¹, may be attributed to ClF₆⁺.

(C) The X-ray powder pattern for ClF₆⁺PtF₆ (after subtracting the lines due to ClF₄⁺PtF₆) is relatively simple, indicating high symmetry. The high symmetry of the unit cell of ClF₆⁺PtF₆ (probably cubic) seems reasonable since both ClF₆⁺ and PtF₆⁻ have octahedral symmetries. The only other known compound of the XF₆⁺ YF₆⁻ structure is IF₆⁺SbF₆⁻. (18) This salt has a high symmetry (face-centered cubic) and ClF₆⁺PtF₆⁻ is expected to exhibit similar structural symmetry.

CONFIDENTIAL
Figure 1. Infrared Spectrum of the Mixture of $\text{ClF}_6^+$, $\text{PtF}_6^-$ and $\text{ClF}_4^+$, $\text{PtF}_6^-$.
**TABLE I. (C) X-RAY POWDER DATA FOR CIF$_6^+$PtF$_6^-$**

<table>
<thead>
<tr>
<th>d$_{(obsd)}$</th>
<th>d$_{(calcd)}$</th>
<th>hkl</th>
<th>Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.717</td>
<td>5.74</td>
<td>110</td>
<td>Strong</td>
</tr>
<tr>
<td>4.036</td>
<td>4.06</td>
<td>200</td>
<td>Very Strong</td>
</tr>
<tr>
<td>3.328</td>
<td>3.32</td>
<td>211</td>
<td>Medium</td>
</tr>
<tr>
<td>2.576</td>
<td>2.569</td>
<td>310</td>
<td>Light</td>
</tr>
<tr>
<td>2.334</td>
<td>2.345</td>
<td>222</td>
<td>Medium</td>
</tr>
<tr>
<td>1.999</td>
<td>2.030</td>
<td>400</td>
<td>Light</td>
</tr>
<tr>
<td>1.923</td>
<td>1.915</td>
<td>411</td>
<td>Very Light</td>
</tr>
<tr>
<td>1.774</td>
<td>1.772</td>
<td>421</td>
<td>Very Light</td>
</tr>
<tr>
<td>1.727</td>
<td>1.732</td>
<td>332</td>
<td>Very Light</td>
</tr>
<tr>
<td>1.530</td>
<td>1.535</td>
<td>520, 432</td>
<td>Very Light</td>
</tr>
</tbody>
</table>

* Tentatively identified as having a cubic symmetry.


17. F. Q. Roberto. To be published

### DISTRIBUTION

<table>
<thead>
<tr>
<th>Agency/Institution</th>
<th>Copies</th>
<th>Address</th>
</tr>
</thead>
</table>
| Bureau of Mines                                          | 1      | Attn: ERC Library
                                                        4800 Forbes Avenue
                                                        Pittsburgh PA 15213 |
| Central Intelligence Agency                             | 1      | Attn: CRS/ADD-Standard Dist
                                                        Washington DC 20505 |
| Chemical Propulsion Info Agency                          | 2      | 8621 Georgia Avenue
                                                        Silver Spring MD 20910 |
| Defense Documentation Center                             | 20     | Attn: TSR
                                                        Cameron Station, Bldg. 5
                                                        Alexandria VA 22314 |
| Defense Rsch. & Engrg                                     | 1      | Pentagon, 3D1065
                                                        Attn: Propulsion Technology
                                                        Washington DC 20301 |
| Institute for Defense Analyses                           | 1      | Attn: Classified Library
                                                        400 Army-Navy Drive
                                                        Arlington VA 22202 |
| NASA Lewis Research Center                               | 1      | Attn: Librarian
                                                        21000 Brookpark Road
                                                        Cleveland, OH 44135 |
| NASA Scientific & Tech Info Facility                     | 1      | Attn: SAF/DL, ACQ Div
                                                        P.O. Box 33
                                                        College Park MD 20740 |
| NASA Goddard Space Flight Center                         | 1      | Attn: Library, Code 252
                                                        Greenbelt MD 20771 |
| NASA Langley Research Center                             | 3      | Attn: Librarian
                                                        Langley Station
                                                        Hampton VA 23565 |
| NASA Manned Spacecraft Center                            | 1      | Attn: Library/Code BM6
                                                        Houston TX 77058 |
| NASA Kennedy Space Center                                | 1      | Attn: Library-ATS-132C
                                                        Kennedy Space Center FL 32899 |
                                                        Washington DC 20546 |
| NASA Kennedy Space Center                                | 1      | Attn: Library-ATS-132C
                                                        Kennedy Space Center FL 32899 |
| NASA Air Force Rocket Propulsion Lab                     | 8      | Attn: RPCS
                                                        Edwards CA 93523 |
| NASA Air Force Rocket Propulsion Lab                     | 8      | Attn: RPR
                                                        Edwards CA 93523 |
| NASA Air Force Rocket Propulsion Lab                     | 1      | Attn: RPM
                                                        Edwards CA 93523 |
<table>
<thead>
<tr>
<th>Address</th>
<th>Number</th>
<th>Contact Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFPRL</td>
<td>1</td>
<td>Naval Air Systems Cmd</td>
</tr>
<tr>
<td>Attn: Technical Library</td>
<td></td>
<td>Attn: AIR-330</td>
</tr>
<tr>
<td>Edwards CA 93523</td>
<td></td>
<td>Washington DC 20360</td>
</tr>
<tr>
<td>Foreign Technology Div</td>
<td>1</td>
<td>Naval Ordnance Sys Cmd</td>
</tr>
<tr>
<td>Attn: TDBTL</td>
<td></td>
<td>Attn: ORD-0331</td>
</tr>
<tr>
<td>Wright-Patterson AFB OH 45433</td>
<td></td>
<td>Washington DC 20360</td>
</tr>
<tr>
<td>Army Ballistic Res. Labs</td>
<td>1</td>
<td>Naval Missile Center</td>
</tr>
<tr>
<td>Attn: AMXBR-1</td>
<td></td>
<td>Attn: Code 5632.2, Tech Library</td>
</tr>
<tr>
<td>Aberdeen Proving Grou1 MD 21005</td>
<td></td>
<td>Point Mugu CA 93041</td>
</tr>
<tr>
<td>Army Missile Command</td>
<td>4</td>
<td>Naval Ordnance Laboratory</td>
</tr>
<tr>
<td>Redstone Scientific Info Center</td>
<td></td>
<td>Attn: Library</td>
</tr>
<tr>
<td>Attn: Chief, Document Section</td>
<td></td>
<td>White Oak</td>
</tr>
<tr>
<td>Redstone Arsenal AL 35805</td>
<td></td>
<td>Silver Spring MD 20910</td>
</tr>
<tr>
<td>Army Research Office</td>
<td>1</td>
<td>Naval Weapons Center</td>
</tr>
<tr>
<td>Attn: CRD-AA-1P</td>
<td></td>
<td>Attn: Code 753-Tech Library</td>
</tr>
<tr>
<td>Box CM, Duke Station</td>
<td></td>
<td>China Lake CA 93555</td>
</tr>
<tr>
<td>Durham, NC 27706</td>
<td></td>
<td>Naval Postgraduate School</td>
</tr>
<tr>
<td>Frankford Arsenal</td>
<td>1</td>
<td>Attn: Library, Tech Rpts</td>
</tr>
<tr>
<td>Attn: C2500-Library-B51-2</td>
<td></td>
<td>Section-2124</td>
</tr>
<tr>
<td>(for Propellant &amp; Expl. Section)</td>
<td></td>
<td>Monterey CA 93940</td>
</tr>
<tr>
<td>Picatinny Arsenal</td>
<td>2</td>
<td>Naval Ordnance Station</td>
</tr>
<tr>
<td>Attn: SMUPA-VA6, Librarian</td>
<td></td>
<td>Indian Head MD 20640</td>
</tr>
<tr>
<td>Dover NJ 07801</td>
<td></td>
<td>Naval Research Branch Office</td>
</tr>
<tr>
<td>White Sands Missile Range</td>
<td>1</td>
<td>Attn: Librarian</td>
</tr>
<tr>
<td>Attn: Technical Library</td>
<td></td>
<td>1030 East Green Street</td>
</tr>
<tr>
<td>White Sands MR NM 88002</td>
<td></td>
<td>Pasadena CA 91101</td>
</tr>
<tr>
<td>Naval Air Systems Cmd.</td>
<td>1</td>
<td>Naval Research</td>
</tr>
<tr>
<td>Washington DC 20360</td>
<td></td>
<td>Washington DC 20360</td>
</tr>
<tr>
<td>Naval Air Systems Cmd</td>
<td>2</td>
<td>Naval Ordnance Sys Cmd</td>
</tr>
<tr>
<td>AIR-53671</td>
<td></td>
<td>Attn: ORD-9132</td>
</tr>
<tr>
<td>Washington DC 20360</td>
<td></td>
<td>Tech Library</td>
</tr>
<tr>
<td>Naval Air Systems CMD</td>
<td>1</td>
<td>Naval Special Projects</td>
</tr>
<tr>
<td>Attn: AIR-5366</td>
<td></td>
<td>Attn: Technical Library</td>
</tr>
<tr>
<td>Washington DC 20360</td>
<td></td>
<td>Washington DC 20360</td>
</tr>
</tbody>
</table>
Naval Underwater Weapons
Res Eng Sta
Attn: Tech Library (CS12)
Newport RI 02840

Aerojet-General Corp
Attn: Tech Library
P.O. Box 296
Azusa CA 91702

Aerojet-General Corp
Attn: Library
11711 South Woodruff Ave
Downey CA 90241

Aerojet-General Corp
Attn: Tech Library-2432-2015A
P.O. Box 15847
Sacramento CA 95813

Aerospace Corp
Attn: Tech Info Ctr. Doc. Group
P.O. Box 95085
Los Angeles CA 90045

Aerotherm Corp.
Attn: Library
485 Clyde Ave.
Mountain View CA 94040

Allied Chemical Corp
Attn: Security Officer
P.O. Box 70
Morristown NJ 07960

ARO, Inc
Attn: Technical Documents Library
Arnold AF Station TN 37389

Bell Aerosystems Co
Attn: Technical Library
P.O. Box 1
Buffalo NY 14240

Boeing Co.
Attn: Aerospace Library-8K-38
P.O. Box 3999
Seattle WA 98124

Dow Chemical Co
Scientific Projects Laboratory
Attn: R.S. Karpiuk, Bldg 1710
Midland MI 48641

DuPont Co.
Eastern Division
Attn: Report Clerk, A.R. Steward
Gibbstown NJ 08027

Esso Research & Engineering Co
Attn: Defense Security Officer
P.O. Box 8
Linden NJ 07036

Garrett Corp
Airesearch Mfg. Div
Attn: Tech Library
2525 W. 190th St.
Torrance CA 90509

General Dynamics Corp
Attn: Div. Library, Mail Zone 6-20
P.O. Box 2507
Pomona CA 91766

General Dynamics/Convair
Library & Info Services
P.O. Box 12009
San Diego CA 92112

General Electric Co
Attn: Acquisitions
Bldg 4, Room 109
Daytona Beach FL 32015

Hercules, Inc
Allegany Ballistics Lab
Attn: Tech Library
P.O. Box 210
Cumberland MD 21502

Hercules, Inc
Research Center
Attn: Tech Info Center
Wilmington DE
<table>
<thead>
<tr>
<th>Company Name</th>
<th>Number</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>California Inst of Technology</td>
<td></td>
<td>Jet Propulsion Laboratory Attn: Library, TDS 4800 Oak Grove Drive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pasadena CA 91103</td>
</tr>
<tr>
<td>IIT Research Institute</td>
<td></td>
<td>Attn: Document Library 10 West 35th Street Chicago IL 60616</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lockheed Missiles &amp; Space Co.</td>
<td></td>
<td>Attn: Tech Info Ctr. 50-14 3251 Hanover St Palto Alto CA 94304</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lockheed Propulsion Co</td>
<td></td>
<td>Attn: Library P.O. Box 111 Redlands CA 92373</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marquardt Corp</td>
<td></td>
<td>Attn: Library P.O. Box 2013, So. Annex Van Nuys CA 91409</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Martin Marietta Corp</td>
<td></td>
<td>Attn: Library - Mail No. 6366 Denver Division P.O. Box 179 Denver CO 80201</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Santa Monica CA 90406</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North American Rockwell</td>
<td></td>
<td>Rocketdyne Division Attn: Library Dept 086-306 6633 Canoga Avenue</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Canoga Park CA 91304</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Philco-Ford Corp</td>
<td></td>
<td>Aeronutronic Div Attn: Tech Info Svcs-Acquisitions Ford Road</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Newport Beach CA 92663</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Princeton University</td>
<td></td>
<td>Forrestal Campus Library Attn: Librarian P.O. Box 710 Princeton NJ 08540</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rocket Research Corp</td>
<td></td>
<td>Attn: Technical Library York Center</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Willow Road at NE 116th St. Redmond WA 98052</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rohm &amp; Hass Co.</td>
<td></td>
<td>Redstone Research Labs Attn: Tech Library Huntsville AL 35807</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stanford Research Institute</td>
<td></td>
<td>Document Center For Propulsion Sciences 333 Ravenswood Avenue Menlo Park CA 94025</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Susquehanna Corp.</td>
<td></td>
<td>Atlantic Research Group Attn: Library Shirley Highway at Edsall Rd</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Alexandria VA 22314</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thiokol Chemical Corp</td>
<td></td>
<td>Wasatch Division Attn: Technical Library Brigham City UT 84302</td>
</tr>
<tr>
<td>Company</td>
<td>Division</td>
<td>Attention 1st</td>
</tr>
<tr>
<td>---------------------------------------------</td>
<td>-------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Thiokol Chemical Corp</td>
<td>Elkton Division</td>
<td>Tech Info</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Center</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thiokol Chemical Corp</td>
<td>Huntsville Division</td>
<td>Technical</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Library</td>
</tr>
<tr>
<td>TRW Systems, Inc.</td>
<td></td>
<td>Technical</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Info Center</td>
</tr>
<tr>
<td>United Aircraft Corp</td>
<td></td>
<td>Acquisitions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Librarian</td>
</tr>
<tr>
<td>United Aircraft Corp</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>United Technology Center</td>
<td></td>
<td>Technical</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Library</td>
</tr>
<tr>
<td>University of Denver</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Denver Research Institute</td>
<td></td>
<td>Security</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Officer</td>
</tr>
<tr>
<td>SAMSNO (SMMAP)</td>
<td></td>
<td>Mercury</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AF Unit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post Office</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Los Angeles CA 90045</td>
</tr>
<tr>
<td>Los Alamos Scientific Laboratory</td>
<td></td>
<td>Report</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Library</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Los Alamos NM 87544</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethyl Corporation</td>
<td></td>
<td>Program</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mgr</td>
</tr>
<tr>
<td>TRW Systems, Inc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hercules, Inc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Martin-Marietta Corp</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Midwest Research Institute</td>
<td></td>
<td>Library</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Documents</td>
</tr>
<tr>
<td></td>
<td></td>
<td>425 Volker Blvd</td>
</tr>
<tr>
<td>Northrop Carolina, Inc.</td>
<td></td>
<td>Library</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1450 South Rolling Road</td>
</tr>
<tr>
<td>Olin Mathieson Chemical Corp</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Main Control Room</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Asst Librarian</td>
</tr>
<tr>
<td></td>
<td></td>
<td>275 Winchester Avenue</td>
</tr>
<tr>
<td>Shell Oil Co.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

19/20
The Synthesis of New Ionic Interhalogen Oxidizers (U)

Phase Report July 1968 - July 1969

Roberto, Francisco Q.

October 1969

AFRPL-TR-69-219

AFRPL-TR-69-219

In addition to security requirements which must be met, this document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of AFRPL (REPORT-STINFO), Edwards, California 93523.

Air Force Rocket Propulsion Laboratory
Air Force Systems Command, USAF
Edwards, California

(C) The synthesis of hexafluorochloronium (VII) hexafluoroplatinate (V), \( \text{ClF}_6^+\text{PtF}_6^- \), from the reaction of chlorine pentafluoride and platinum hexafluoride is described as an oxidation-reduction reaction. This has been confirmed by elemental analyses, infrared and Raman spectroscopy, X-ray powder diffraction and displacement reaction with trifluorochlorine oxide. This is the first example of a perfluorinated heptavalent chlorine cation. The compound, \( \text{ClF}_6^+\text{PtF}_6^- \), based on preliminary X-ray powder pattern, has been indexed as having a cubic structure.
<table>
<thead>
<tr>
<th>KEY WORDS</th>
<th>LINK A</th>
<th>LINK B</th>
<th>LINK C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ROLE</td>
<td>WT</td>
<td>ROLE</td>
</tr>
<tr>
<td>Heptavalent chlorine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hexafluorochloronium</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interhalogen</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>