Xtreme Prototypes

X-15A-2 SPECIAL EDITION v2.0
UTILITY FLIGHT MANUAL

ADD-ON ROCKET AIRCRAFT for LOCKHEED MARTIN® PREPAR3D® and MICROSOFT® FLIGHT SIMULATOR X

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NEWS & RELEASE NOTES

New Native Version for Prepar3D® v4

The X-15A-2 Special Edition v2.0 addon now includes a native version (labeled v2.01) for the new 64-bit Prepar3D® v4 simulation platform.

A special installer for Prepar3D® v4 is available from our "Downloads" section on our website. The update is free for registered users.

This updated version contains 64-bit DLLs and will not work in previous versions of Prepar3D® (nor in FSX).

What's new in v2.01 for Prepar3D® v4:

■ New 64-bit sound DLL compatible with the new simulation platform

■ New special effects optimized for the latest versions of Prepar3D®

■ A revised ignition system to solve engine start issues encountered in Prepar3D®

■ An improved flight model for better stability at high velocities and with the SAS engaged (autopilot)

■ A revised 280-page utility flight manual

All other features are the same as in previous versions.

Installing in Prepar3D® v3

There is no special installer for Prepar3D® v3 available for this addon at this time. To install this addon in Prepar3D® v3, please use the installer for Prepar3D® v2 and change the path to your simulation platform during installation. The version for Prepar3D® v2 is compatible with Prepar3D® v3.

For optimized performance, we recommend upgrading your simulation platform to the 64-bit Prepar3D® v4.x and to use the installer for Prepar3D® v4 (see left).

NEWS & RELEASE NOTES *(cont'd)*

Latest Patches and Updates

Please visit our "Downloads" section on our website for the latest patches and software updates for your addon:

http://xtremeprototypes.com/en/downloads.asp

(2018-02-08) New Installer for Prepar3D® v4.x. The X-15A-2 Special Edition v2.0 addon now includes a native version (labeled v2.01) for the new 64-bit Prepar3D® v4 simulation platform. This updated version contains 64-bit DLLs and new features including new special effects, a revised ignition system, an improved flight model and a revised 280-page utility flight manual. Use this installer to install your addon in Prepar3D® v4.x. Free for registered users (all versions).

(2015-01-15) New Installer for Microsoft® Flight Simulator X: Steam® Edition. The X-15A-2 Special Edition is now fully compatible with Microsoft® Flight Simulator X: Steam® Edition. Use this installer to install your addon in FSX: Steam® Edition. Free for registered users (all versions).

(2015-01-09) Special Effects Package. Special effects appearance may vary from system to system, depending on many factors including your simulation platform, your version of DirectX®, your view aspect ratio and your graphics hardware and settings. If you are not satisfied with the effects on your system (for example, they are too small or too big), try replacing the special effect files. This package contains different sets of effects for your X-15A-2 SE addon. Free for registered users (all versions).

THANK YOU FOR PURCHASING YOUR LICENSE

We thank you for purchasing your software license for using this product. Xtreme Prototypes is a small addon developer and we depend largely on your feedback and support to create better products. Contributions from our users, in the form of software license purchases, allow us to pursue our mission. By doing so, you are contributing to the making of unique high quality addons for advanced desktop pilots. In addition, your license gives you access to free personalized technical support, product information, patches and updates.

This manual is to be used in conjunction with the Xtreme Prototypes X-15A-2 Special Edition addon only. It is part of a software package and it is subject to the terms of use specified in the enclosed end-user software license agreement. As a registered user, you are authorized to print copies of this manual for your own use, in conjunction with the Xtreme Prototypes X-15A-2 Special Edition simulation software.

TABLE OF CONTENTS

NORMAL PROCEDURES AND CHECK LIST   6

QUICK-START PROCEDURES   7

EMERGENCY PROCEDURES   8

APPENDICES

FOREWORD

Thank you for your interest in our X-15A-2 Special Edition addon for Microsoft® Flight Simulator X and Lockheed Martin® Prepar3D®.

The Xtreme Prototypes X-15A-2 Special Edition is the first of our next generation of addons optimized for the latest versions of Flight Simulator X and Prepar3D®, and designed to take advantage of the new and more powerful personal computer systems that are available today.

This new addon in our X-15 Series features entirely new high-resolution models and textures, highly detailed virtual cockpits with full-3D gauges, additional systems and functionalities, new animations, and new special visual effects and sounds, among many other features.

The X-15A-2 SE is the result of several years of research and took nearly two years to develop. Our goal was to create a new X-15 addon with the necessary features to make it as accurate as possible both technically and historically, offering a higher level of realism, within the limitations and capabilities of the currently available simulation platforms. We believe we achieved this goal by offering our X-15 fans a new and completely redesigned product that, in addition of being visually impressive, includes almost every systems and functionalities found in the real aircraft.

This addon will allow you to fly at altitudes of over 300,000 feet at more than four times the speed of sound (or the maximum speed that can be attained in the simulator) and to recreate almost every step and procedure required in a typical X-15 research mission.

The Xtreme Prototypes X-15A-2 SE is the ideal complement to X-15 books and films and will take you as close as you can get to flying the world's fastest aircraft.

We hope you will enjoy flying the new A2 as much as we enjoyed developing this exciting addon.

INTRODUCTION AND PRODUCT DESCRIPTION

ABOUT THE REAL X-15

The real X-15 was a single-place rocket-powered experimental aircraft built by North American Aviation in the late 1950's and early 1960's for NASA (NACA), the U.S. Air Force and the U.S. Navy to test flight at extremely high speeds and altitudes and to obtain data on the effects of such flight conditions on the aircraft and on the pilot.

The X-15 was capable of and achieved high speed and altitude records such as Mach 6.7 or 6629 fps (more than twice as fast as a speeding bullet) and 354,200 feet.

Three X-15 rocket planes were built during the X-15 research program, which overall cost more than $300 million (a colossal sum at the time). The program succeeded at demonstrating the ability of pilots to fly rocket-propelled aircraft out of the Earth's atmosphere and back to precision landing. Today, the X-15 can be considered as history's first reusable spacecraft.

After being dropped at a high altitude from a modified B-52 carrier airplane and propelled by its million-horsepower rocket engine at several times the speed of sound, the X-15 would fly to the edge of space, burn all its fuel, perform reentry into the atmosphere and finally glide its way back to land on a dry lake in the high desert of California.

The X-15-1, equipped with the "interim" Reaction Motors XLR-11 rocket engines, was rolled out in October 1958, and was transferred to Edwards Air Force Base for testing. Its first captive flight (while the X-15 is attached to the carrier airplane) occurred in March 1959 followed by its first glide flight in June of the same year. On January 23, 1960, the X-15-1, with NAA test pilot Scott Crossfield, successfully completed its first powered flight attaining Mach 2.53 and 66,844 feet with the two XLR-11 rocket engines.

In February 1961, the X-15-1 was returned to North American Aviation for conversion to its design-mission configuration (which required the powerful XLR-99 engine), after completing 21 flights with the XLR-11 engines.

NASA pilot Bill Dana flew the X-15-1 for the last time on October 24, 1968. The No. 1 aircraft completed 81 flights during the entire X-15 program.

The X-15-2 aircraft arrived at Edwards in April 1959 and made its first powered flight with the XRL-99 engine more than a year later, in November 1960, after completing nine flights with the XLR-11 engines.

In November 1962, the X-15-2 airplane was extensively damaged during an emergency landing, after the flaps refused to operate and the left landing skid failed. It was decided to rebuild the airplane as a modified "advanced" version of the X-15, with a longer fuselage and external propellant tanks. The "extended performance" X-15A-2 was rolled out in February 1964.

In October 1967, Air Force pilot Pete Knight took the X-15A-2 to Mach 6.7 (4520 mph), the fastest manned aircraft flight recorded to this day by a winged vehicle (excluding the Space Shuttle).

The X-15-3 was delivered to Edwards in June 1959, equipped with the XLR-99 engine. In August 1963, NASA pilot Joe Walker set an altitude record of 354,200 feet in the No. 3 aircraft. Sadly, the X-15-3 was lost in November 1967 after the airplane entered a hypersonic spin, descended in an inverted dive at almost Mach 4 and 65,000 feet and finally broke up, taking the life of Air Force pilot Michael Adams.

Together, the three aircraft completed 199 flights during a nine-year period, the 200th one being canceled several times in November and December, 1968. It was the end of the X-15 program.

After almost 40 years, the X-15 still holds impressive speed and altitude records. It was one of the most successful research aircraft tested at Edwards AFB.

Twelve test pilots flew the X-15: Michael Adams (USAF), Neil Armstrong (NASA), Scott Crossfield (NAA), Bill Dana (NASA), Joe Engle (USAF), Pete Knight (USAF), Jack McKay (NASA), Forrest Peterson (USN), Bob Rushworth (USAF), Milt Thompson (NASA), Joe Walker (NASA) and Bob White (USAF).

Today, the X-15-1 hangs from the ceiling in the main gallery of the Smithsonian National Air and Space Museum in Washington, D.C. The X-15A-2 is on display at the National Museum of the United States Air Force (Wright-Patterson Air Force Base, Dayton, Ohio).

WHAT'S NEW IN VERSION 2.0?

New high-resolution 3D exterior models — Three high-resolution 3D exterior models, optimized for the latest versions of Microsoft® Flight Simulator X and Lockheed Martin® Prepar3D®, with more than 1900 parts and 100 animations.

New high-resolution textures — Eleven high-resolution texture variations with unique liveries for each aircraft.

A fictitious model of a delta wing X-15 — Three variations of a fictitious delta wing X-15AD-4 aircraft with rocket engine nozzle extensions, solid rocket boosters and auxiliary vertical stabilizers, based on different pro-

posed configurations for future X-15 aircraft.

New high-resolution fully functional 3D virtual cockpits — Three fully functional high resolution virtual cockpits with over 1500 parts and 300 full-3D animated gauges, switches, levers, light indicators, flight instruments and systems with integrated tooltips.

New switches and levers — New switches, control sticks, handles and levers to conform better to the real X-15A-2 panels. All the switches in the VCs are clickable.

Fully functional breaker panel — The breaker panel on the right console is now fully functional with 33 clickable breakers.

An automatic ignition sequence — The X-15A-2 can now be started automatically at the touch of a single "magic" button located on the main panel. This is similar to pressing "CTRL+E" with conventional aircraft in the simulator. However, the red button initiates all X-15A-2 custom systems, including her unique three-propellant rocket fuel management system. You can use this button to properly start the engine without going through the normal procedures and check list.

New X-15 dynamic sound sets — The X-15A-2 now comes with new X-15 dynamic sound sets, including new solid rocket booster sound effects. In addition to the basic sounds, additional effects (APUs, turbopump, engine precool/prime and fuel jettison effects) are included.

New extra sound effects — Over 50 new additional sound effects, including external and

cockpit sounds (switches, knobs and levers, breakers, pneumatic valves, propellant tank pressurization, gyro, blower fans, tank and ventral jettison, etc.). Contains Bill Leaming's FBGS sound system to play these sounds.

New visual effects — Over 25 X-15-specific low and high altitude visual effects.

Multiple camera views — Version 2.0 now has 10 external camera views. These views show the vertical rudder, speed brakes, horizontal stabilizer, external tanks, rocket boosters and wing flaps. Also included are left and right canopy views, a rear engine view and a "B-52 window" view showing the X-15A-2 from her top left side. Users can cycle forward or backward the different camera views using the "**S**" and "**A**" keys or a button on the joystick.

New cockpit spotlights — The virtual cockpits and external models feature new cockpit spotlights that are lit when the cockpit lighting switch on the right wing panel is turned on.

"Invisible" canopy mode — The yellow canopy emergency jettison handle on the right wing panel can now be pulled to make the X-15 clamshell-type canopy "invisible". The handle does not open the canopy. It simply makes it "invisible" on both the VC and the external model.

Seven new saved flights, some based on actual X-15A-2 historical missions — It is now easier to prepare the X-15A-2 for takeoff or to simulate an X-15 launch at a high altitude over different dry lakes by loading one of the new saved flights. There are two categories of X-15 flights: the fictitious "takeoff" flights and the high altitude "launch" flights, based on historical X-15 missions.

A revised and expanded 280-page PDF manual and an online help system — The PDF manual and the online help system are in part based on the original X-15A-2 utility flight manual. The online help system is optimized for tablets and PCs (Internet connection and browser required). You can use your iPad®, Windows® or Android® tablet as an aviator kneeboard while flying the X-15A-2 addon. Your online manual is always up-to-date and contains a new X-15 system descriptions section.

Other new features include:

- Two Thiokol "Castor 1", 45,000-pound solid rocket boosters with engine nozzles (on delta wing model only), with new jettison animation

- Functional engine compartment fire detection system

- Detailed ejection seat with animated handles, buttons, armrests, foot restraints, deflectors and oxygen gauge and selector switch

- Modified X-15 radio for use in the simulator (VHF COM1, COM2, ADF, VOR)

- Optional radio-magnetic indicator (user-selectable)

- Fully animated 3D attitude indicator (pitch, roll, azimuth)

- Basic autopilot functions

- New temperature control systems

- New cockpit pressurization system

- New cockpit air conditioning system with blowers

- Dynamic frost (around the cold propellant tanks when filled)

- Animated ram-air door

- Optional trapezoidal windows (user-selectable)

- Animated skylight hatch with star tracker system

- Dynamic fogging and ablator splatters on selected windows

- Functional windshield heating (antifogging) system, complete with animated valve handles and dynamic frost/fog on the windshield

- Animated ball nose

- Detailed canopy cover with floodlights, electrical and antifogging systems, animat-

ed valves, electrical wires and nitrogen pipes, animated head restraint and movie camera

- New detailed and fully animated landing skids and front gear ("steerable" in the simulator), with scoop door and a flexible electrical cable

- Detailed split-flap speed brakes with flexible hoses

- New external propellant tanks with new jettison animation

- New animated X-15 astronaut/pilot in full pressure suit

ADDON DESCRIPTION

The **Xtreme Prototypes X-15A-2 Special Edition 2.0** for Microsoft® Flight Simulator X and Lockheed Martin® Prepar3D® brings the excitement of high speed and high altitude flight and the challenge of an X-15 research mission to the desktop PC.

The addon contains eight (8) variations of the X-15A-2 with external propellant tanks and the mighty XLR-99 rocket engine and three (3) fictitious variations of a delta wing X-15AD-4 with rocket engine nozzles and solid rocket boosters, based on proposed configurations for future X-15 aircraft.

Each aircraft is fully detailed and has been carefully modeled based on available drawings, flight manuals, photographs, films and other archive material in order to conform as

closely as possible to the real-world X-15A-2.

The highly detailed exterior models feature more than 1900 parts and 100 animations. Three fully functional 3D virtual cockpits contain over 1500 parts and 300 animated custom gauges and systems. A custom X-15 flight model was designed to reproduce the characteristics of rocket-powered high speed and high altitude flights in the simulator.

Contrary to the real X-15A-2 that was launched at a high altitude from a carrier airplane, the X-15A-2 addon can take off from an airport runway like any other aircraft in the simulator. The flight model allows the airplane to accelerate up to approximately Mach 4.65 (or the current maximum speed supported by the simulator), drop its external tanks, reach an altitude of over 300,000 feet, burn most of its fuel, complete its ballistic trajectory, decelerate, jettison its remaining propellants and ventral, and finally glide its way back to the nearest dry lake or runway.

General Features

Four variations of the X-15A-2 aircraft (s/n AF56-6671) with the XLR-99 rocket engine, a long ventral and external propellant tanks:

- Clean black "rollout" version (circa 1964) with silver drop tanks

- Standard black version (circa 1965) with red and white drop tanks

- Standard black version (circa 1966) with pink ablative patches and black and white drop tanks

- Standard black version (circa 1966) with pink ablative patches and red, black and white drop tanks

Four variations of the X-15A-2 aircraft (s/n AF56-6671) with the XLR-99 rocket engine, external propellant tanks, a short ventral, a dummy ramjet and an animated eyelid on the left canopy window:

- "Refurbished" (museum) black version (circa 1969) with red and white drop tanks

- Pink version with full ablative coating (circa 1967)

- Clean white version with full ablative coating and white sealer (circa 1967), with red, black and white drop tanks

- Standard white version with full ablative coating and white sealer (circa 1967), with red, black and white drop tanks

Three variations of a fictitious delta wing X-15AD-4 aircraft (s/n AF68-18601 and N203NSX) with the XLR-99 rocket engine, rocket engine nozzle extensions, solid rocket boosters, auxiliary vertical stabilizers and a dummy ramjet, based on different proposed configurations:

- Clean black "rollout" version (circa 1969)

- Standard black version (circa 1969)

- White "NASA" version (circa 1970)

Flight Model Features

Custom X-15 flight model to reproduce the characteristics of rocket-powered high speed and high altitude flights in the simulator:

- One Reaction Motors XLR-99, "throttable" 60,000-pound liquid-fuel turborocket engine

- Two Thiokol "Castor 1", 45,000-pound solid rocket boosters (on delta wing model only)

- Supersonic flight up to the maximum speed attainable in the simulator (approx. Mach 4.65)

- High-altitude flight up to 354,200 feet (or the maximum altitude attainable in the simulator)

- Fictitious ground takeoff or high altitude launch like the real aircraft

- Good maneuverability at supersonic speeds

- Excellent gliding capabilities

X-15A-2 Rocket Aircraft Systems

The following aircraft systems are simulated to conform as closely as possible to the operation of the real aircraft, within the present limitations and capabilities of the simulator:

- Custom X-15 fuel management system for the three different types of propellants and gases, like in the real X-15A-2 rocket plane (overrides the simulator's conventional fuel management system)

- Engine compartment fire detection system

- Engine turbopump system

- Turbopump hydrogen peroxide system

- XLR-99 power plant propellant and control systems

- Engine controls and indicators

- Propellant supply system

- Liquid oxygen tank

- Ammonia tank

- Engine and propellant control helium system

- Propellant pressurization helium system

- Drop tank system

- Propellant transfer system (from external drop tanks)

- Solid rocket booster ignition system (delta wing model only)

- Auxiliary power units (APUs)

- Electrical power supply systems (generators, AC/DC power distribution, emergency battery and an external power source)

- Temperature control systems

- Hydraulic power supply systems

- Flight control systems and indicators (vertical and horizontal stabilizers, flaps, speed brakes)

- Landing gear system

- Instruments (pitot static, stable platform, ball nose)

- SAS (basic autopilot functions), ASAS

- BCS, RAS (animated switches and lights, BCS not supported in the simulator at this time)

- Instrumentation system controls and indicators (skylight hatch)

- Indicator, caution and warning light system

- Canopy

- Ejection seat (limited functionalities, animation only)

- Air conditioning and pressurization system

- Nitrogen system

- Windshield heating (antifogging) system

- Radio communication, VOR and ADF system

- Cockpit lighting system

- Pilot's oxygen system

Aircraft Model Features

- Three high resolution 3D exterior models, optimized for the latest versions of Microsoft® Flight Simulator X and Lockheed Martin Prepar3D®

- Detailed models based on archive material, with more than 1900 parts and 100 animations

- High resolution textures

- Unique markings and liveries (on each aircraft)

- Dynamic frost textures (around the cold propellant tanks when filled)

- Movable aerodynamic control surfaces:

  - Differential horizontal stabilizer

  - Vertical stabilizers with movable and fixed sections and a jettisonable ventral rudder

  - Flaps

  - Fully animated upper and lower split-flap speed brakes with flexible hoses

- Detailed and fully animated landing skids and nose gear ("steerable" in the simulator), with scoop door and a flexible electrical cable

- Animated ram-air door

- Detailed canopy cover with floodlights, electrical and antifogging systems, animated valves, electrical wires and nitrogen pipes, animated head restraint and movie camera

- Elliptical canopy windows on all models (default)

- Optional trapezoidal windows (user-selectable)

- Detailed cockpit with ejection seat, animated sticks and levers, and miscellaneous systems

- Animated X-15 astronaut/pilot in full pressure suit

- Animated skylight hatch with star tracker system

- Detailed XLR-99 power plant with exhaust pipe and jettison and drain pipes

- Jettisonable external propellant tanks (optional, user-selectable)

- Fictitious delta wing model with auxiliary vertical stabilizers, based on proposed configurations for future X-15 aircraft

- Jettisonable solid-fuel rocket boosters on delta wing model

- Rocket engine nozzles on delta wing model

- Jettisonable dummy ramjet (on the white aircraft)

- Animated eyelid on the left canopy window of selected aircraft

- Dynamic fogging and ablator splatters on selected windows

- Animated ball nose

- Retractable pitot tube

Virtual Cockpit Features

- Three fully functional high resolution virtual cockpits with over 1500 parts and 300 full-3D animated gauges, switches, levers, light indicators, flight instruments and systems with tooltips

- Advanced instrument panels:

  - Main panel with two wing panels (engine and flight instruments and control, electrical and hydraulic instruments and controls, light indicators, cockpit instruments, engine timer, landing gear handle, emergency canopy handle, SAS panel, retractable pitot handle)

  - Left console (VPJ control box and lever, flap switch, RAS lights, BCS control stick, engine throttle, speed brake handle, drop tank controls, radio panel, pressure suit controls, left side control box)

  - Right console (breaker panel, cooling lever and switches, right control stick, canopy handle)

  - Center pedestal (instrumentation control panel, ram-air levers, DC voltmeter)

- Three fully animated control sticks (user-selectable)

- Animated rudder pedals

- Elliptical canopy windows on all models (default)

- Animated eyelid on the left canopy window

of the white aircraft (with internal lever)

- Dynamic ablator spills on selected windows

- Optional trapezoidal windows (user-selectable) for a better outside view from the cockpit

- Invisible canopy mode to fly the X-15 without the clamshell-type canopy on, offering a spectacular view from the cockpit (user-selectable)

- Detailed canopy cover with floodlights, electrical and antifogging systems, animated valves, electrical wires and nitrogen pipes, animated head restraint and movie camera

- Functional windshield heating (antifogging) system, complete with animated valve handles and dynamic frost/fog textures on the windshield

- Cockpit floodlights (VC and exterior model, switchable)

- Detailed ejection seat with animated handles, buttons, armrests, foot restraints, deflectors and oxygen gauge and selector switch

- Modified X-15 radio for use in the simulator (VHF COM1, COM2, ADF, VOR)

- Fully functional breaker panel

- Optional radio-magnetic indicator (user-selectable)

- Access to the default Garmin GPS unit

Visual Effects

Over 25 X-15-specific visual effects, including:

- Rocket engine combustion flames and shockwave effects

- Engine first and/or second stage igniter effects

- Rocket engine smoke and contrail effects

- Propellant jettison effects (fuel, LOX and

H_2O_2)

- Engine turbopump exhaust effect

- APU exhaust effects

- Engine precool and prime effects

- LOX bleed effect

- Condensation and vapor effect around the cold LOX tank when filled

- Cockpit lights

- Wing vortices and vapor trails

Sound Effects

- New X-15 sound sets, including a new solid rocket booster sound effect

- Over 50 additional sound effects, including external and cockpit sounds (switches, knobs and levers, breakers, pneumatic valves, propellant tank pressurization, APUs, turbopump, gyro, blower fans, fuel jettison, engine precool and prime, tank and ventral jettison, etc.)

Miscellaneous

- Automatic rocket engine ignition sequence start button for beginner pilots

- System monitor panels

- Contains Bill Leaming's FBGS sound system for playing cockpit sounds

- Ten (10) external camera views

- Seven (7) saved flights, some based on X-15A-2 historical missions, to simulate a high altitude launch or a fictitious takeoff from the ground

- A revised and expanded 280-page printable PDF manual

- A new online help system optimized for PCs and tablets (Internet connection and browser required)

Main instrument panel in the virtual cockpit of the X-15A-2 SE (Prepar3D® v2 screenshot).

ABOUT THE ONLINE HELP SYSTEM

Xtreme Prototypes now offers online help systems in addition to PDF flight manuals for some of its addons. Online help systems offer much more features than PDF manuals, such as high-resolution images, interactive multimedia contents, hyperlinks, keywords, and a search engine, and they occupy less space than printed documents. In addition, online manuals are always up-to-date, so you are never left behind.

Online help systems can be viewed in your Internet browser on your desktop or laptop computer or tablet. Like many pilots in the real world, you can use your iPad®, Windows® or Android® tablet as an aviator kneeboard while flying the aircraft in the simulator.

You can use the table of contents on the left to browse the different topics or search for phrases and keywords to get the information you want quickly. Keywords and hyperlinks are important features of online help systems that will help you navigate and find what you need.

- Click the "Contents" tab for the table of contents. Click the individual topics in the table to navigate to the full content (there are about 225 topics in the online manual).

- Click the "Index" tab for a list of keywords. Click the individual keywords to navigate to their corresponding topics (there are about 400 keywords in the online manual).

- Click the "Search" tab to search for words, phrases or topics. Click the topics in the search result to navigate to the full content.

You can access the online help system for the X-15A-2 SE addon at any time by visiting our website:

http://xtremeprototypes.com/en/X-15A-2SE_help/X-15A-2SEUserManual.html

Important

- Online help systems are updated frequently. If you suspect that you don't have the

latest manual update, we suggest that you clear your Web browser cache.

- There is no checklist and reference information in the aircraft kneeboard (available in the simulator). Everything is included in the documentation. Refer to "Quick Start Procedures" (checklist) and "Aircraft Reference Information".

GIVE THE MANUAL A CHANCE!

The operation of the X-15A-2 addon is very similar to the operation of the real aircraft. For proper operation, users must read the manual and follow the procedures carefully.

The X-15 is certainly no ordinary aircraft. As an experimental vehicle equipped with a powerful rocket engine that uses three different types of propellants, the X-15A-2 SE is very different from more conventional piston or jet aircraft addons normally found in the simulator. Like a real X-15 test pilot, the desktop pilot needs some time to become familiar with the complex operation of this remarkable and unique aircraft and to become able to perform the required procedures described in the manual. It is simply impossible to jump in the cockpit of the X-15A-2 SE addon and expect to start the rocket engine and to take off without following the correct procedures, like in the real aircraft.

All the necessary information to fly the X-15A-2 SE addon is in the manual and the online documentation. There are two sets of instructions: a detailed set, which contains the entire procedures involved in a real X-15A-2 flight

(perfect for X-15 fans and more advanced desktop pilots), and a condensed set called "quick-start procedures", for those who want a shorter check list.

For beginners, we've included a "magic" red button on the main instrument panel to bypass normal procedures and start the engine ignition sequence automatically. However, following each step presented in the manual will make your overall X-15 experience much more realistic and enjoyable.

The X-15A-2 SE v2.0 documentation contains a new section with complete system descriptions that was not included in the old (v1.0) manual (see section 5). All systems, switches, indicators, gauges, levers and handles are described in full.

If you're feeling overwhelmed by the cockpit of the X-15A-2, we suggest giving the manual a chance, as it was written with non-experienced pilots in mind. The aircraft is quite rewarding once mastered, but as most things in life, practice makes perfect!

Manuals are updated regularly. Please make sure you have the latest revision:

http://xtremeprototypes.com/en/manuals_downloads.asp

SCOPE

This manual contains the necessary information for the installation and operation of the Xtreme Prototypes X-15A-2 Special Edition addon on your simulation platform.

Nearly all X-15 systems that can be reproduced in Microsoft® Flight Simulator X or Lockheed Martin® Prepar3D® are simulated, unless otherwise noted.

For technical and historical accuracy and in an effort to recreate what it was like to prepare and operate the real X-15A-2, portions of the documentation are inspired or adapted from the original X-15 and X-15A-2 utility flight manuals.

While we regard this addon more as an aircraft simulator rather than a game, we cannot pretend that it is one hundred percent historically or technically accurate or that it truly reproduces all the flight characteristics of the real X-15A-2 rocket plane, which would be practically impossible to achieve on the currently available simulation platforms. However, we tried our best to develop a unique and sophisticated product that puts the desktop pilot in command of one of the most extraordinary flying machines and let him/her forget for one moment that it's not for real.

A WORD ABOUT PIRACY

Piracy is not a victimless crime.

Developing high quality professional addons for the latest simulation platforms is becoming more and more complex and requires the contribution of a dedicated and passionate team of artists, technicians, engineers and pilots. These products cost money to develop and require many months of research and hard work, and are aimed at a relatively limited market of serious flight simulation enthusiasts.

Xtreme Prototypes is a small addon developer and we depend largely on your feedback and support to create better products. Contributions from our users, in the form of software license purchases, allow us to pursue our mission.

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MINIMUM SYSTEM REQUIREMENTS

The X-15A-2 Special Edition v2.0 is an add-on software package that requires Microsoft® Flight Simulator X with Acceleration Expansion Pack (or Flight Simulator Gold fully installed), Flight Simulator X: Steam® Edition or Lockheed Martin® Prepar3D® to be installed on your computer.

The software is not a stand-alone product and cannot be used without the underlying simulation platform. Make sure that your simulation platform has been properly installed according to the instructions provided by the manufacturer before installing this addon.

Important

- Xtreme Prototypes next generation addons are designed to take advantage of the new and more powerful personal computer systems that are available today. They require better video cards and more processing power and RAM than other more conventional addons. Before installing this product, make sure you have the minimum system requirements or better. Increased performance will be noticed on more powerful systems.

- Windows® 10/8.1/8/7 or later is required to install and fly this addon. We are sorry we cannot provide support for this addon if installed under Windows® Vista™ or Windows® XP®.

Note to FSX: Steam® Edition Users

- The X-15A-2 SE addon is fully compatible with Flight Simulator X: Steam® Edition. A new installer is available from our "Downloads" section (free for registered users). Refer to "Software Installation" for more details.

Note to Prepar3D® Users

- The X-15A-2 Special Edition v2.0 addon now includes a native version (labeled v2.01) for the new 64-bit Prepar3D® v4 simulation platform. A special installer for Prepar3D® v4 is available from our "Downloads" section on our website. This updated version contains 64-bit DLLs and will not work in previous versions of Prepar3D® (nor in FSX). The update is free for registered users.

- There is no special installer for Prepar3D® v3 available for this addon at this time. To install this addon in Prepar3D® v3, please use the installer for Prepar3D® v2 and change the path to your simulation platform during installation. The addon version for Prepar3D® v2 is compatible with Prepar3D® v3.

- For optimized performance, we recommend upgrading your simulation platform to the 64-bit Prepar3D® v4.x and to use the installer for Prepar3D® v4 (see above).

- Note that the versions for Prepar3D® v1 and FSX are compatible with all versions of Prepar3D®, except the 64-bit v4.

Flight Simulation Platform (depending on the addon version installed): Microsoft® Flight Simulator X with Acceleration Expansion Pack (or Flight Simulator X Gold fully installed), Flight Simulator X: Steam® Edition or Lockheed Martin® Prepar3D® v1/2/3/4. This product is not compatible with earlier versions of Microsoft® Flight Simulator.

Operating System: Windows® 10/8.1/8/7 (or later) 32-bit (64-bit recommended)*

Computer Memory (RAM): 8 GB (16 GB or more recommended)*

Processor: Dual Core 3.0 GHz (Quad Core 3.0 GHz or better recommended)*

Hard Drive Space: Each addon version uses approx. 3 GB when installed.

Video Card: 1 GB (a high-end video card with 2 GB GDDR5 or better is highly recommended)*. Installing this addon in Prepar3D® v2 and later requires a DirectX® 11-compatible video card*. Make sure you have the latest video driver for your operating system.

Graphics: DirectX® 11, 10 or 9 (depending on your simulator's requirements)*

Other: Wheel mouse, joystick (pedals optional), sound card and speakers, Adobe® Acrobat Reader®

Internet Connection: An Internet connection with browser is required to access the online help system (optimized for tablets and PCs). You can use your iPad®, Windows® or Android® tablet (optional) as an aviator kneeboard while flying the X-15A-2 SE.

*: Please refer to your simulator's documentation for more information.

COMPATIBILITY, PERFORMANCE AND SETTINGS

The Xtreme Prototypes X-15A-2 Special Edition addon is optimized for the latest versions of Microsoft® Flight Simulator X with Acceleration Expansion Pack (or Flight Simulator X Gold fully installed), Flight Simulator X: Steam® Edition and Lockheed Martin® Prepar3D®.

Make sure that you install the correct addon version for your simulation platform. The currently available installers are for Flight Simulator X (FSX), Flight Simulator X: Steam® Edition (FSX Steam), Prepar3D® v1 (P3Dv1), Prepar3D® v2 (P3Dv2) and Prepar3D® v4 (P3Dv4). To install this addon in Prepar3D® v3, please use the installer for Prepar3D® v2.

Important

- This addon is not compatible with Flight Simulator X with Service Pack 2 alone. You will need to install the Acceleration Expansion Pack in addition to FSX SP2.

- This addon is not compatible with Microsoft® Flight Simulator 2004.

- The addon versions for Flight Simulator X and Prepar3D® v1 are compatible with Prepar3D® v2 and v3. However, we recommend installing the correct addon version for your simulation platform to avoid special effect issues and to benefit from extra features.

- The version for Prepar3D® v2 is a native version that is not compatible with Prepar3D® v1 and Flight Simulator X. Make sure that you install the correct addon version for your simulation platform.

- The version for Prepar3D® v2 is compatible with Prepar3D® v3.

- The addon versions for Flight Simulator X and Prepar3D® v1 and v2 are not compatible with Prepar3D® v4. Make sure that you install the correct addon version for your simulation platform.

- The updated version for Prepar3D® v4 contains 64-bit DLLs and will not work in previous versions of Prepar3D® (nor in FSX).

- Unfortunately, we won't be able to complete the X-Plane® version of our X-15A-2 SE addon, as previously announced. Development of the X-15A-2 SE for X-Plane® has been halted and the project is on hold until further notice.

As a rule of thumb, if your simulation platform is running properly on your computer, and assuming that your computer meets the minimum system requirements, you should be able to install and fly the X-15A-2 SE addon without major issues.

There seems to be no limit to the maximum altitude to be attained by the X-15A-2 in FSX or Prepar3D® (which was limited to 100,000 feet in FS2004). For example, it is now possible to recreate the highest flight of the X-15 program achieved by X-15-3 on August 22, 1963 (354,200 feet), even though the highest altitude attained by the real X-15A-2 rocket plane was 249,000 feet (August 3, 1966). Unfortunately, speed is still limited to approximately Mach 4.65 on all current platforms.

Performance

The X-15A-2 Special Edition addon was designed with its overall visual quality, complex systems and most accurate simulation features in mind. It was designed as an experimental aircraft to be flown in areas with limited weather, traffic and terrain features, such as in the desert area surrounding Edwards AFB where the X-15 program was conducted.

Unless your computer hardware allows it, we do not recommend flying the addon in high traffic zones, over high density terrain such as major cities because this may affect the frame rate and have a negative impact on the overall X-15 simulation. Of course, all this depends on your computer hardware and your simulation platform's settings. Increased performance will be noticed on more powerful systems and these restrictions may no longer apply in the near future.

The many complex custom systems designed for the X-15A-2 addon are responsible four thousands of calculations at each computer cycle. These systems, combined with the new high-resolution models and textures, hundreds of cockpit animations and some of the special visual and sound effects, may affect your frame rate on slower processors and video cards, depending on your simulation platform's settings. Adjust your simulation platform's display, weather and traffic settings to correct this problem if necessary or upgrade your computer system with more processing power and a better video card.

Under normal conditions and with the recommended settings in this section, assuming that your computer meets or exceeds the minimum system requirements, you should expect acceptable frame rates of between 20 to 60 frames per second, depending on your hardware and settings. Average frame rate should be between 30 to 45 fps. Frame rates below 20 fps are not normal under these conditions, unless they are temporary.

We recommend limiting your frame rate to 30 fps on all platforms. This will free computer resources for other tasks and will improve performance.

Most of our tests were performed under Windows® 8.1 in a 1920 x 1200 simulation window, with a screen resolution of 5760 x 1200 on all simulation platforms:

- Dell® XPS 8500

- Intel® (Quad Core) i7-3770 CPU @ 3,40 GHz, 64 bit

- 16 GB RAM

- AMD® Radeon® HD 7700 Series video card (2 GB GDDR5)

Refer to the documentation included with your simulation platform for more information about minimum system requirements and how to optimize your settings for the best overall performance.

Important

- Make sure you have the latest video card driver for your operating system.

- Make sure your antivirus program is not scanning your system while you are flying in the simulator. This could greatly affect performance.

RECOMMENDED SETTINGS

Because there are as many computer systems as they are users, it is impossible to recommend unique settings that would fit all systems. However, assuming that your computer hardware meets the minimum system requirements, below are the recommended settings for the supported simulation platforms based on our own experience with the X-15A-2 SE addon. These settings may vary from system to system and experimentation is required.

Recommended settings for Flight Simulator X

Below are the recommended settings for Microsoft® Flight Simulator X with Acceleration Expansion Pack (or Flight Simulator X Gold fully installed), based on our own experience, assuming that your computer meets the minimum system requirements. Please note that some of these settings, such as the unlimited

SETTINGS - DISPLAY

GRAPHICS | AIRCRAFT | SCENERY | WEATHER | TRAFFIC

Global settings: Custom   Reset Defaults

Device-specific options
Device:
AMD Radeon HD 7700 Series.0
Target frame rate: 24
Full screen resolution:
5760x1200x32
1920x1200x32
3072x768x16
1024x768x16
1280x720x16
1280x800x16
1280x1024x16
1600x1200x16
Filtering: Anisotropic
☑ Anti-aliasing

Global options
Global texture resolution: High
☐ Preview DirectX 10
☐ Lens flare
☐ Light bloom
☑ Advanced animations

Informational text
⦿ Continuous
◯ Single line

HELP | CANCEL | OK

SETTINGS - DISPLAY

GRAPHICS | AIRCRAFT | SCENERY | WEATHER | TRAFFIC

Global settings: Medium High   Reset Defaults

Cockpit settings
Default cockpit view
⦿ 3-D virtual cockpit
◯ 2-D instrument panel

☑ Show cockpit ToolTips
☑ High-resolution 3-D virtual cockpit

2-D panel transparency (%): 0

Exterior settings
☑ Aircraft casts shadows on the ground
☐ Aircraft casts shadows on itself
☑ Aircraft landing-lights illuminate ground

HELP | CANCEL | OK

SETTINGS - DISPLAY

GRAPHICS | AIRCRAFT | SCENERY | WEATHER | TRAFFIC

Global settings: Custom   Reset Defaults

Visual settings
Cloud draw distance: 90mi / 144km
Thermal visualization:
Natural

Cloud detail
◯ Simple clouds
⦿ Detailed clouds
Cloud coverage density: Maximum

Simulation settings
☐ Download winds aloft data with real-world weather
☐ Disable turbulence and thermal effects on aircraft
Rate at which weather changes over time: Medium

HELP | CANCEL | OK

SETTINGS - DISPLAY

GRAPHICS | AIRCRAFT | SCENERY | WEATHER | TRAFFIC

Global settings: High   Reset Defaults

Terrain and water
Level of detail radius: Medium
Mesh complexity: 70
Mesh resolution: 76 m
Texture resolution: 2 m
Water effects: Mid 2.x
☑ Land detail textures

Scenery objects
Scenery complexity: Dense
Autogen density: Normal
☐ Ground scenery shadows
Special effects detail: High

HELP | CANCEL | OK

SETTINGS - DISPLAY

GRAPHICS | AIRCRAFT | SCENERY | WEATHER | TRAFFIC

Global settings: Low   Reset Defaults

Aviation traffic
Airline traffic density (%): 5
General aviation traffic density (%): 5
Airport vehicle density: Minimum

Aircraft labels
☑ Show aircraft labels
☐ User aircraft   ☐ Tail number
☑ Manufacturer   ☑ Distance
☑ Model   ☑ Altitude
Label color: Cycle rate:
Red   1   seconds

Land and sea traffic
Road vehicles (%): 0   Ships and ferries (%): 10   Leisure boats (%): 15

HELP | CANCEL | OK

SETTINGS - REALISM

Current realism settings:
Custom

Flight model
General:
P-factor:
Torque:
Gyro:
Crash tolerance:
easy   realistic

Instruments and lights
☐ Pilot controls aircraft lights
☐ Enable gyro drift
◯ Display true airspeed
⦿ Display indicated airspeed

☐ Display flying tips

Crashes and damage
⦿ Ignore crashes and damage
◯ Detect crashes and damage
☐ Aircraft stress causes damage
☐ Allow collisions with other aircraft

Engines
☑ Enable automixture
☑ Unlimited fuel
☐ Engine stress damages engine

Special Effects
☐ G-effects

Flight controls
☐ Autorudder

HELP | CANCEL | OK

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fuel option, are required for the X-15A-2 SE addon only, due to its custom fuel management system that bypasses the simulator's own fuel management system.

Of course, these settings may vary from system to system and experimentation is required.

Known Issues in Flight Simulator X

■ If you experience "blue texture" flashes in FSX when the addon textures are loading, especially when in the virtual cockpit, we recommend disabling the DirectX® 10 Preview option in your "Display" settings ("Graphics" tab). FSX seems to perform better under DirectX® 9. This may also im-

prove how the X-15 visual effects are displayed.

- If the special visual effects don't look like the images in this documentation or simply disappear when viewed at certain angles, uncheck the Preview DirectX® 10 option box. Third-party free DirectX® 10 shader fixers are also available in Flight Simulation forums. Refer to "Special Visual Effects" for more details and options.

- The font used in the system monitor panel may appear jagged under DirectX® 9. This seems to be a minor simulator issue. We don't know of any fix at this time.

- We noticed that occasionally, and for no apparent reason, the frame rate would drop significantly (3-5 fps) at the beginning of a new flight in FSX. This would be clearly noticeable in the virtual cockpit. Of course, this is not normal and we believe it is a simulator issue, not an addon issue. It may occur when many changes are made at the beginning of a new flight, like changing the time and season and switching aircraft several times. If you didn't experienced slow rate issues with the X-15A-2 SE addon before, simply reset the flight to solve the issue.

- If some parts on the external model are missing after loading a saved flight from the "Free Flight" page in FSX with the same aircraft that appear in the aircraft preview window, resetting the flight will return things to normal. This simulator issue has been resolved during the beta tests by going around it. Loading the same flight from the top menu bar did not create any issue so we don't know at this time what might have caused this anomaly.

- It's been reported during the beta tests that some third-party addons or FS utilities may interfere with the correct installation of the X-15A-2 SE addon. These programs may also alter the appearance of your add-on aircraft by modifying the textures and the materials in the model files. If the different X-15A-2 aircraft variations are correctly displayed in the "Select Aircraft" page but you are unable to select any one of them, or worse if selecting them causes FSX to crash, suspect such third-party pro-

grams. For unknown reasons, these programs may prevent the addon's system DLLs from being "trusted" by FSX and the addon will not work. Remove these programs to solve the issue.

Optional Settings

Other optional settings require that you modify the "fsx.CFG" file located in "C:\Users*your name*\AppData\Roaming\Microsoft\FSX". It is not Xtreme Prototypes' policy to modify the user's "fsx.CFG" file during the installation process. So this needs to be done manually by the user.

NOTE (FSX: Steam® Edition): The "fsx_se.CFG" file is located in "C:\Users*your name*\AppData\Roaming\Microsoft\FSX-SE".

Should you decide to change these settings, please make sure that you've made a backup copy of your original "fsx.CFG" (or "fsx_se.CFG) file and saved it in a safe place before proceeding:

To prevent the dynamic head movement in the virtual cockpit under strong acceleration, which may be very distracting when flying the X-15, you can make the following changes:

```
[DynamicHeadMovement]
LonAccelOnHeadLon=0.000000
LonAccelOnHeadPitch=0.000000
RollAccelOnHeadLat=0.000000
YawAccelOnHeadLat=0.000000
RollAccelOnHeadRoll=0.000000
MaxHeadAngle=0.000000
MaxHeadOffset=0.000000
HeadMoveTimeConstant=0.000000
```

If you have a widescreen monitor and feel you are too close to the main panel in the virtual cockpit even after zooming out or moving the seat aft, you can make the following change:

```
[Display]
WideViewAspect=True
```

Note: The special effects for Flight Simulator X are optimized for a wide-view aspect ratio. If you are using a standard-view aspect ratio, the effects may appear too small (or too thin). To solve this issue, simply replace the default effects with the ones included in the "FSX Steam

Effects (1.65)" folder contained in the Special Effects Package. Visit the "Downloads" section on our website and download the Special Effects Package. Read the instructions included with the Special Effects Package. Refer to "Special Visual Effects" for more details.

Note: The special effects for Flight Simulator X: Steam® Edition are optimized for a standard-view aspect ratio. If you are using a wide-view aspect ratio, the effects may appear too big (or too large). To solve this issue, simply replace the default effects with the ones included in the "FSX P3Dv1 Effects (1.00)" folder contained in the Special Effects Package. Visit the "Downloads" section on our website and download the Special Effects Package. Read the instructions included with the Special Effects Package. Refer to "Special Visual Effects" for more details.

If you own a powerful computer equipped with a high-end video card, you can make the following changes to optimize the graphics (the X-15A-2 SE addon uses 2048 x 2048 textures):

```
[Display]
TEXTURE_BANDWIDTH_MULT=80

[Graphics]
TEXTURE_MAX_LOAD=2048
```

or

```
[Graphics]
TEXTURE_MAX_LOAD=4096
```

Note: If you still experience performance issues after optimizing your simulation platform, you may need to upgrade your computer system. Refer to "Minimum System Requirements".

Note to FSX: Steam® Edition Users

- This section also applies to Flight Simulator X: Steam® Edition.

- The X-15A-2 SE addon is fully compatible with Flight Simulator X: Steam® Edition. A new installer is available from our "Downloads" section (free for registered users). Refer to "Software Installation" for more details.

Recommended settings for Prepar3D® v1

Below are the recommended settings for Lockheed® Martin Prepar3D® v1, based on our own experience, assuming that your computer meets the minimum system requirements. Please note that some of these settings, such as the unlimited fuel option, are required for the X-15A-2 SE addon only, due to its custom fuel management system that bypasses the simulator's own fuel management system. Of course, these settings may vary from system to system and experimentation is required.

Refer to your simulator's documentation for more details.

Settings - Scenery

Settings - Weather

Settings - Traffic

Settings - Realism
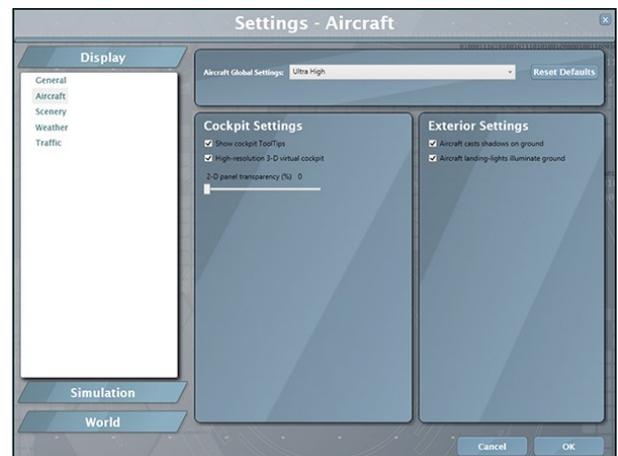
Known Issues in Prepar3D® v1

- The font used in the system monitor panel may appear jagged in Prepar3D® v1. This seems to be a minor simulator issue. We don't know of any fix at this time.

- If the special visual effects don't look like the images in this documentation, refer to "Special Visual Effects" for some options.

Note: The special effects for Prepar3D® v1 are optimized for a wide-view aspect ratio. If you are using a standard-view aspect ratio, the effects may appear too small (or too thin). To solve this issue, simply replace the default effects with the ones included in the "FSX Steam Effects (1.65)" folder contained in the Special Effects Package. Visit the "Downloads" section on our website and download the Special Effects Package. Read the instructions included with the Special Effects Package. Refer to "Special Visual Effects" for more details.

Optional Settings

Other optional settings require that you modify the "Prepar3D.CFG" file located in "C:\Users*your name*\AppData\Roaming\Lockheed Martin\Prepar3D". It is not Xtreme Prototypes' policy to modify the user's "Prepar3D.CFG" file during the installation process. So this needs to be done manually by the user.

Should you decide to change these settings, please make sure that you've made a backup copy of your original "Prepar3D.CFG" file and saved it in a safe place before proceeding:

To prevent the dynamic head movement in the virtual cockpit under strong acceleration, which may be very distracting when flying the X-15, you can make the following changes:

```
[DynamicHeadMovement]
LonAccelOnHeadLon=0.000000
LonAccelOnHeadPitch=0.000000
```

```
RollAccelOnHeadLat=0.000000
YawAccelOnHeadLat=0.000000
RollAccelOnHeadRoll=0.000000
MaxHeadAngle=0.000000
MaxHeadOffset=0.000000
HeadMoveTimeConstant=0.000000
```

If you own a powerful computer equipped with a high-end video card, you can make the following changes to optimize the graphics (note that the X-15A-2 SE addon uses 2048 x 2048 textures):

```
[Display]
TEXTURE_BANDWIDTH_MULT=80
```

```
[Graphics]
TEXTURE_MAX_LOAD=2048
```

or

```
[Graphics]
TEXTURE_MAX_LOAD=4096
```

Note: If you still experience performance issues after optimizing your simulation platform, you may need to upgrade your computer system. Refer to "Minimum System Requirements".

Recommended settings for Prepar3D® v2 and v3

Lockheed® Martin Prepar3D® v2/3 is a professional simulation platform that requires a powerful computer and video card to run. We do not recommend flying the X-15A-2 SE addon in Prepar3D® v2/3 if you don't have the required computing power and high-end video hardware.

Note: Prepar3D® v2/3 requires DirectX® 11 and a DirectX® 11-compatible video card. Refer to your simulator's documentation for more details.

Advanced lighting options in Prepar3D® v2/3, such as shadows and HDR lighting, may dramatically affect performance and reduce frame rate. We recommend moderation when setting these options, especially on slower systems.

Dynamic Reflections (Prepar3D® v3) should be turned **OFF (or unchecked)**. The X-15A-2 SE addon uses its own static cubic environment

map. Turning on Dynamic Reflections has no effect and might decrease performance on your system.

Below are the recommended settings for Lockheed® Martin Prepar3D® v2/3, based on our own experience, assuming that your computer meets the minimum system requirements.

Settings - Weather

Settings - Traffic

Settings - Realism
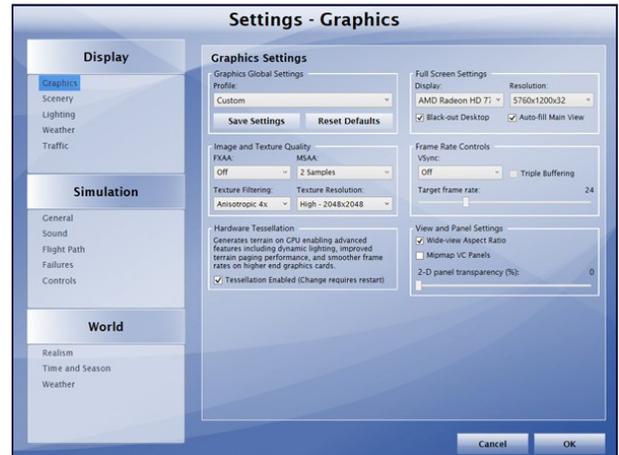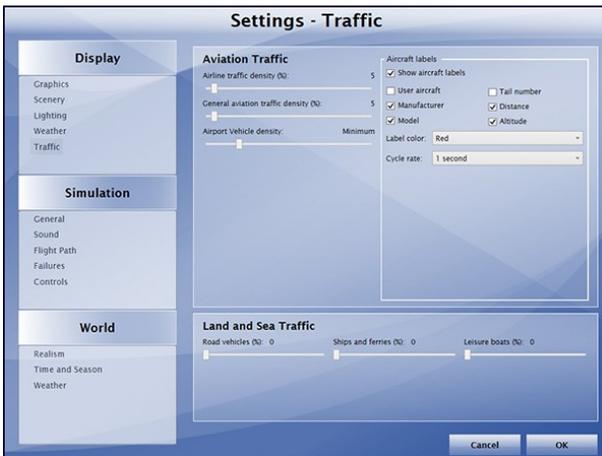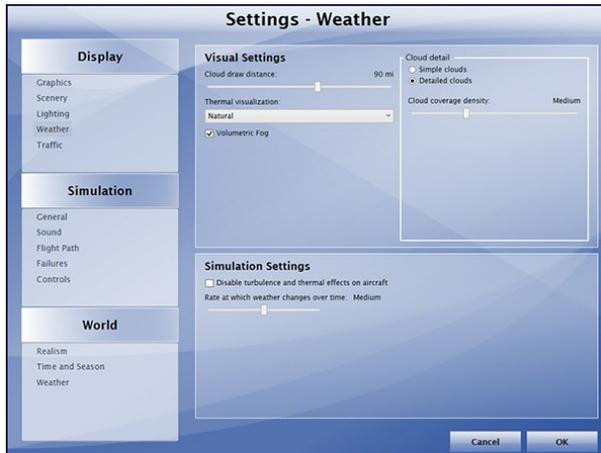
Known Issues in Prepar3D® v2/3

■ The special effect engine was changed from CPU to GPU with the release of Prepar3D® v2. This has the advantage of freeing computer resources and improving performance on high-end graphics hardware. The X-15A-2 SE special visual effects were upgraded to conform to the Prepar3D® v2 (and later) specifications. While the new Prepar3D® v2/3 particle effects are visually identical to the FSX/Prepar3D® v1 effects, there is a simulator issue affecting extrusion effects that still needs to be resolved. Until then, extrusion effects such as engine contrails, wing vortices and vaportrails, APU exhaust and propellant jettison effects at high speed and altitude may appear sawtoothed, wrongly oriented, faded, delayed, with repeating arrow patterns. This is normal until a fix is made available. Refer to "Special Visual Effects" for more details and options.

■ No special effect issue related to the view aspect ratio was reported in Prepar3D® v2/3.

Optional Settings

For optimal graphics quality, make sure the texture resolution is set to "High - 2048x2048" in your graphics settings (under "Image and Texture Quality"). The X-15A-2 SE addon uses 2048 x 2048 textures.

Other optional settings require that you manually modify the "Prepar3D.cfg" file located in " C : \ U s e r s \ *y o u r name*\AppData\Roaming\Lockheed Martin\Prepar3D v2/3". It is not Xtreme Prototypes' policy to modify the user's "Prepar3D.cfg" file during the installation process. So this needs to be done manually by the user.

Should you decide to change these settings, please make sure that you've made a backup copy of your original "Prepar3D.cfg" file and saved it in a safe place before proceeding.

To prevent the dynamic head movement in the virtual cockpit under strong acceleration, which may be very distracting when flying the X-15, you can make the following changes:

Please note that some of these settings, such as the unlimited fuel option, are required for the X-15A-2 SE addon only, due to its custom fuel management system that bypasses the simulator's own fuel management system.

Of course, these settings may vary from system to system and experimentation is required.

```
[DynamicHeadMovement]
LonAccelOnHeadLon=0.000000
LonAccelOnHeadPitch=0.000000
RollAccelOnHeadLat=0.000000
YawAccelOnHeadLat=0.000000
RollAccelOnHeadRoll=0.000000
MaxHeadAngle=0.000000
MaxHeadOffset=0.000000
HeadMoveTimeConstant=0.000000
```

Note: If you still experience performance issues after optimizing your simulation platform, you may need to upgrade your computer system. Refer to "Minimum System Requirements".

Recommended settings for Prepar3D® v4

Lockheed® Martin Prepar3D® v4 is a professional simulation platform that requires a powerful computer and video card to run. We do not recommend flying the X-15A-2 SE addon in Prepar3D® v4 if you don't have the re-

quired computing power and high-end video hardware.

Note: Prepar3D® v4 requires DirectX® 11 and a DirectX® 11-compatible video card. Refer to your simulator's documentation for more details.

Advanced lighting options in Prepar3D® v4, such as shadows and HDR lighting, may dramatically affect performance and reduce frame rate. We recommend moderation when setting these options, especially on slower systems.

Dynamic Reflections should be turned **OFF (or unchecked)**. The X-15A-2 SE addon uses its own static cubic environment map. Turning on Dynamic Reflections has no effect and might decrease performance on your system.

Dynamic Lighting should be turned **OFF (or unchecked)**. The X-15A-2 SE addon is not compatible with this new feature at this time.
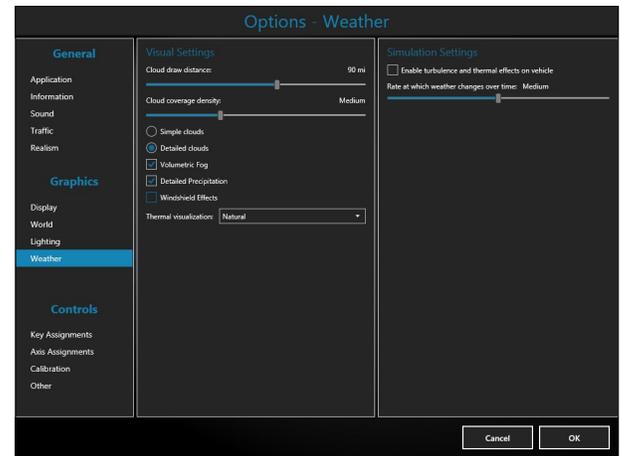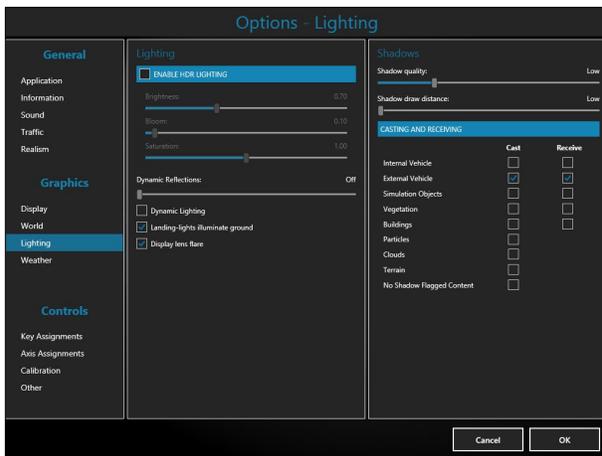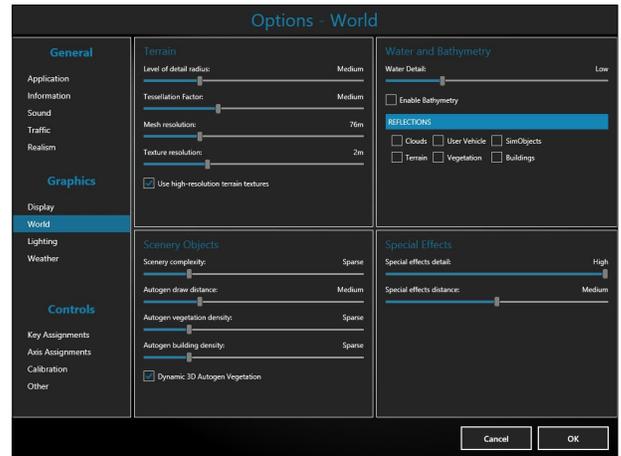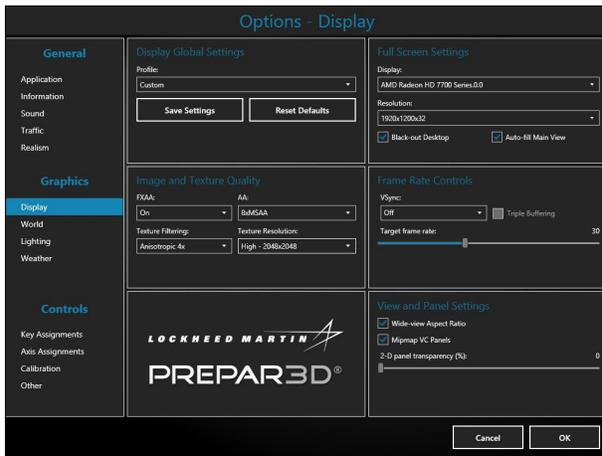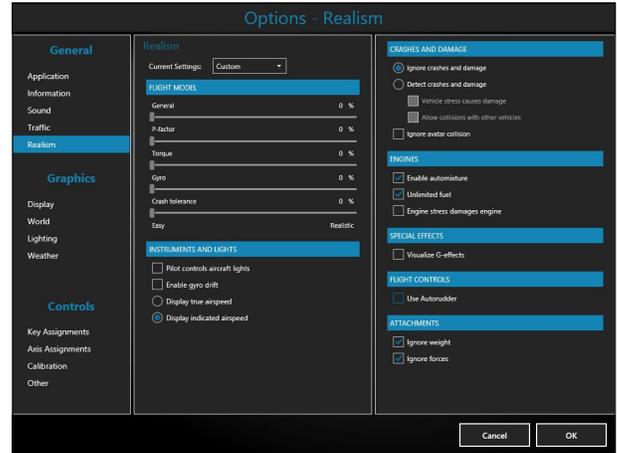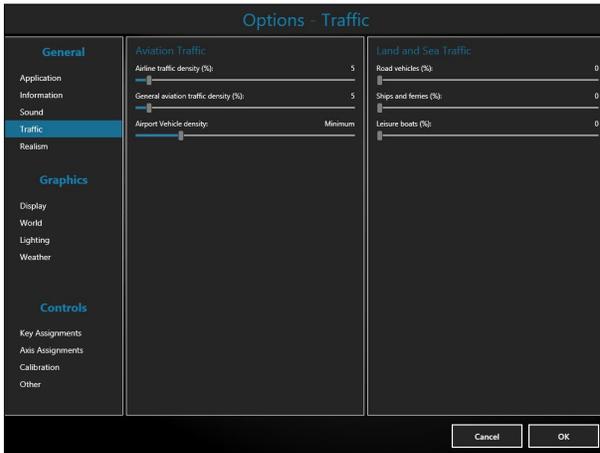
Below are the recommended settings for Lock-

heed® Martin Prepar3D® v4, based on our own experience, assuming that your computer meets the minimum system requirements.

Please note that some of these settings, such as the unlimited fuel option, are required for the X-15A-2 SE addon only, due to its custom fuel management system that bypasses the simulator's own fuel management system.

Of course, these settings may vary from system to system and experimentation is required.

Optional Settings

For optimal graphics quality, make sure the texture resolution is set to "High - 2048x2048" in your graphics settings (under "Image and Texture Quality"). The X-15A-2 SE addon uses 2048 x 2048 textures.

Other optional settings require that you manually modify the "Prepar3D.cfg" file located in " C : \ U s e r s \ *y o u r name*\AppData\Roaming\Lockheed Martin\Prepar3D v4". It is not Xtreme Prototypes' policy to modify the user's "Prepar3D.cfg" file during the installation process. So this needs to be done manually by the user.

Should you decide to change these settings, please make sure that you've made a backup copy of your original "Prepar3D.cfg" file and saved it in a safe place before proceeding.

To prevent the dynamic head movement in the virtual cockpit under strong acceleration, which may be very distracting when flying the

X-15, you can make the following changes:

```
[DynamicHeadMovement]
LonAccelOnHeadLon=0.000000
LonAccelOnHeadPitch=0.000000
RollAccelOnHeadLat=0.000000
YawAccelOnHeadLat=0.000000
RollAccelOnHeadRoll=0.000000
MaxHeadAngle=0.000000
MaxHeadOffset=0.000000
HeadMoveTimeConstant=0.000000
```

Note: If you still experience performance issues after optimizing your simulation platform, you may need to upgrade your computer system. Refer to "Minimum System Requirements".

DOWNLOADING YOUR ADDON

Our products are available for download only.

At this time, you should have downloaded the ZIP file that contains the original installers for Prepar3D® v2/3, Prepar3D® v1 and FSX from our website and received your personal activation key by email.

Note: Please contact us if you have not received your activation key or were unable to download your addon after your order was processed.

The special installers for Prepar3D® v4 and FSX Steam® are available separately, from our "Downloads" section on our website (see instructions below).

The installers (one for each simulation plat-

form) are contained in ZIP files to prevent them from being blocked by some antivirus programs while the addon is being downloaded from our website (some anti-virus software won't allow you to download ".exe" files).

Make sure you are authorized to download ZIP files on your system (check your antivirus software) or you may not be able to download your addon.

The main ZIP file ("**XP_X-15A-2_SE_v2r0.zip"**) weights approximately 1.26 GB and normally takes about 5 to 15 minutes to download on a high speed Internet connection.

You can download your addon again at any time by logging in to our website. Once you are logged in, on the "Your Account" page, select "**Review or re-download previous order(s)**", click on your order number, and click the link to download your addon. To protect your account, you may download the file a limited number of times. After that, you will need to contact us if you need the file again.

You can also download only the individual installer(s) needed for your simulation platform (s). When in your account page, select "**Download available patches and updates for your addon(s)**". Fill in the form with your order number and activation key and select the file(s) you want to download (one file at a time). Click the "Download File" button to download the file.

You can also access our "Downloads" section directly (user account required):

https://xtremeprototypes.com/en/downloads.asp

Once downloaded, save the ZIP file on your computer desktop.

Please note that the replacement of lost downloaded files is not guaranteed. We recommend making an extra copy for your own use and to save it in a safe place along with your personal activation key. Refer to the end-user software license agreement for more details.

Note to Prepar3D® v4 Users

- The X-15A-2 SE addon now includes a na-

tive version (labeled v2.01) for the new 64-bit Prepar3D® v4 simulation platform. A special installer for Prepar3D® v4 ("**XP_X-15A-2_SE_v2r01_P3Dv4.zip")** is available from our "Downloads" section (free for registered users).

Note to FSX: Steam® Edition Users

- The X-15A-2 SE addon is fully compatible with Flight Simulator X: Steam® Edition. A special installer ("**XP_X-15A-2_SE_v2r0_FSX_Steam.zip"**) is available from our "Downloads" section (free for registered users).

Known Download Issues

- If you don't have a high speed Internet connection, or experience intermittent connection issues, you may be timed out or disconnected while transferring the file. If you are not able to download your addon after several attempts, we recommend using another and better connection either at work (if allowed) or at a parent's or friend's. If you don't have access to another connection, and still cannot solve the issue, please contact us for other options.

- We recommend using your Internet browser (Internet Explorer, Chrome, etc.) to download your addon. Do not use a third-party download manager or you may experience problems that were reported by a number of users.

- Some antivirus programs may also prevent you from downloading your addon. Make sure your antivirus does not interfere with your downloads. Also, some antivirus won't allow you to download "zip" or ".exe" files. You can disable your antivirus program temporarily (while downloading your addon) to solve this issue. Don't forget to reactivate your antivirus after the file is downloaded.

PACKAGE DESCRIPTION

Extracting the Installers from the ZIP Files

To extract the installers from the ZIP files, right click the ZIP file and select "**EXTRACT ALL...**". Follow the instructions to extract and save the installers to your desktop.

The available installers are:

- **"XP_X-15A-2_SE_v2r01_P3Dv4_setup.exe"** for Prepar3D® v4 only

- **"XP_X-15A-2_SE_v2r0_P3Dv2_setup.exe"** for Prepar3D® v2/3 only

- **"XP_X-15A-2_SE_v2r0_P3Dv1_setup.exe"** for Prepar3D® v1

- **"XP_X-15A-2_SE_v2r0_FSX_Steam_setup.exe"** for Flight Simulator X: Steam® Edition

- **"XP_X-15A-2_SE_v2r0_FSX_setup.exe"** for Flight Simulator X

These installers contain the addon and all its components to be installed on your computer.

Note: Because of differences between simulation platforms, the installers are not interchangeable.

You may install multiple versions of the X-15A-2 SE addon concurrently on your computer if you are using more than one simulation platform. However, we recommend installing only the version(s) you intend to use. Each addon will occupy about 3 GB of disk space on your computer when installed.

Note: The installer will not erase nor replace our previous (legacy) version 1.0 of the X-15A-2 addon, if installed on your computer. The new version will be installed in different folders. You may choose to delete or keep the previous version before installing the new version. We suggest deleting the old version.

SOFTWARE INSTALLATION

You will need a valid activation key to install your addon. Please contact us if you did not received your activation key by email moments after your order was processed.

Installation on one simulation platform at a time:

1. Make sure that the required simulation platform has been properly installed according to the instructions provided by the developer before you install your new X-15A-2 SE addon. If your simulation platform is currently running, please close the program before proceeding with the installation. **Make sure you are using the proper installer for your simulation platform (refer to "Package Description").**

2. **Double-click the installer file for your simulation platform (the one that ends with "setup.exe") and follow the instructions that appear on screen.** Enter your name and personal activation key when asked. You must accept the end-user license agreement and enter a valid activation key before you can install and use your addon. The installer will copy the required files to their proper location on your computer.

Important

- The installer cannot detect the path to your simulation platform's root folder (directory) automatically. If you installed

Flight Simulator X or Prepar3D® in a custom folder at a different location on your computer, you will need to specify the correct path/folder during the installation process. You have nothing to do if your simulation platform is installed in its default folder/location.

Note: If you have more than one simulation platform installed on your computer, repeat the previous step for each addon version you want to install. Each installer has a different name (refer to "Package Description").

Note to FSX: Steam® Edition Users

- Please note that FSX: Steam® Edition is installed in a different way to the boxed version and occupies a different location on your computer. With the standard installer for FSX, you will need to specify a different path/root folder during the installation process to deploy the addon into FSX: Steam® Edition (by default: "C:\Program Files (x86)\Steam\steamapps\common\FSX").

- Also, with the standard installer, you will need to copy the saved flights from the "C:\Users\your name\Documents\Flight Simulator X Files" folder to your "C:\Users\your name\Documents\Flight Simulator X - Steam Edition Files" folder. This is because FSX: Steam® Edition uses a different folder to store your saved flights.

- For these reasons, we recommend using the new installer for FSX: Steam® Edition that is available from our "Downloads" section (free for registered users).

- Please note that the new installer for FSX: Steam® Edition cannot detect the path to your simulation platform's root folder (directory) automatically. If you installed Flight Simulator X: Steam® Edition in a custom folder at a different location on your computer, you will need to specify the correct path/folder during the installation process. You have nothing to do if your simulation platform is installed in its default folder/location.

Security Warnings (FSX/FSX Steam®)

Note: This section applies only to Flight Simulator X and Flight Simulator X: Steam® Edition (see note above). Security warnings are not an issue in Prepar3D®.

In addition to many other files, important software components need to be installed, trusted and run on your computer for the X-15A-2 SE addon to function. These are contained in software libraries called "DLLs".

These DLLs are copied to the addon's panel folder during the installation process. You must trust these modules and allow them to run on your computer or the addon will not work.

Standard Windows® security warning dialogs will pop up the first time the X-15A-2 SE addon is loaded in the simulator, asking if you allow the DLLs to run on your computer. Click the "**Run**" button to accept. This needs to be done only once.
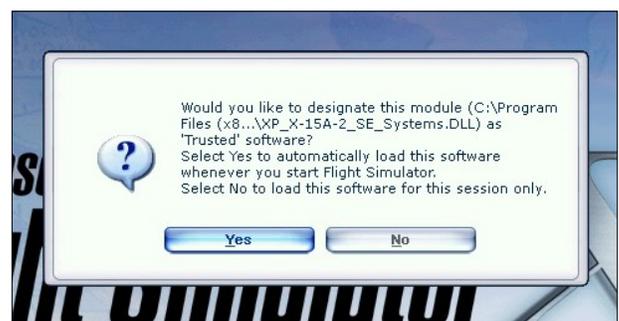
Another dialog will pop up in your simulator's main window the first time the X-15A-2 SE addon is loaded. This time it asks if you trust the DLLs. Click the "**Yes**" button to designate the DLL as "trusted" software. This needs to be done only once.

Important

▪ The X-15A-2 SE addon will not work without these DLLs. You must allow them to be installed, trusted and run.

Checking the Installation

Once the addon is installed, the different aircraft variations will be available on the "Select Aircraft" (or "Select Vehicle") page in your simulation platform.

The X-15A-2 SE addon consists of eleven variations of the X-15A-2 rocket plane. If some aircraft variations are not visible, make sure the "**Show all variations**" option is selected on the "Select Aircraft" page.

Note: The "Select Aircraft/Vehicle" page may be different from the ones shown below and on the next page, depending on your simulation platform.

Known Issue (FSX)

▪ It's been reported during the beta tests that some third-party addons or FS utilities may interfere with the correct installation of the X-15A-2 SE addon. These programs may also alter the appearance of your addon aircraft by modifying the textures and the materials in the model files. If the different X-15A-2 aircraft variations are correctly displayed in the "Select Aircraft" page but you are unable to select any one of them, or worse if selecting them causes FSX to crash, suspect such third-party programs. For unknown reasons, these programs may prevent the addon's system DLLs from being "trusted" by FSX and the addon will not work. Remove these programs to solve the issue.

Known Issues (All platforms)

▪ Some antivirus programs may interfere

with or prevent the installation of the critical DLLs mentioned above. The X-15A-2 SE addon will not work without these DLLs (some aircraft parts will be missing or frozen, there will be no cockpit sounds). To solve this issue, disable your antivirus program temporarily while reinstalling your addon. Don't forget to reactivate your antivirus after the addon is installed and working properly.

- If there is no sound from the cockpit (when clicking a switch) or some aircraft parts are missing on both the exterior model and the virtual cockpit, try resetting the flight. It this does not solve the issue, it may be because some important software components are missing or were not installed properly during the installation process. Check the About panel, available from the "Views/Instruments" menu item on your simulator's top menu bar, to check if some components are missing. If so, you will need to reinstall the addon to solve

this issue. Make sure your antivirus program does not interfere with the installation. Contact us if you still cannot solve the issue after reinstalling the addon.

File Structure

The X-15A-2 SE aircraft models, textures, sounds, systems and configuration files are installed under different names in different folders in your "... *simulator name*\SimObjects\Airplanes" folder.

The special visual effects are installed in your "... *simulator name*\Effects" folder and the saved flights are installed in your "C:\Users*your name**simulator name* Files" folder.

Known Issue (FSX in another language than English)

- If you are using Flight Simulator X in another language than English, you will need to manually move the saved flights from the "C:\Users*your name*\Documents\Flight Simulator X Files" folder to your "C:\Users*your name*\Documents*Flight Simulator X Files in your language*" folder. This is because Flight Simulator X changes the name of your saved flight folder, depending on your language. For example, while the folder name "Flight Simulator X Files" is used in English, it becomes "Fichiers Flight Simulator X" in French. The installer cannot detect the language of your simulation platform so you will have to copy or move the saved flight files manually. This is not an issue in Prepar3D® or FSX Steam®.

Removing the X-15A-2 SE addon from your computer

The X-15A-2 SE v2.0 addon can be removed from the Windows® Control Panel (Program/Uninstall a Program), like any other program.

Do not use the uninstallation program (uninstall.exe) directly. The uninstallation program is located in the application folder that was created during the installation process and is used by the Windows® Control Panel.

You are now ready to go!

AIRCRAFT DESCRIPTION AND SPECIFICATIONS

SECTION 3

The real X-15 was a single-place research rocket airplane, specifically designed to obtain data on flight at extremely high altitudes and speeds and on the effects of such flight conditions on the aircraft and on the pilot.

Built by North American Aviation in the late 1950s and early 1960s, under public contract by NACA (NASA), the U.S. Air Force and the U.S. Navy, the airplane was developed and tested in two basic configurations:

- The limited-mission configuration included two interim Reaction Motors XLR-11 ("Experimental Liquid Rocket-11"), 5900-pound four-chambered turbo-rocket engines and either a conventional flight reference system or an inertial flight data system;

- The design-mission configuration included an inertial flight reference system and one Reaction Motors XLR-99, 60,000-pound liquid-propellant turbo-rocket engine. All other systems and components for each airplane configuration were essentially the same.

The 25½ degree swept back wing [2, fig. 3-1] had hydraulically operated flaps on the inboard trailing edge of each wing panel. All aerodynamic control surfaces were actuated by irreversible hydraulic systems.

The horizontal stabilizer had a 15-degree cathedral. The left and right sections moved simultaneously for pitch control, differentially for roll control, and in compound for pitch-roll control.

The upper and lower vertical stabilizers (rudders) were in two sections; a movable outer span for yaw control and a fixed section adjacent to the fuselage. The lower movable section (ventral) was jettisonable for landing. Each fixed section incorporated a split-flap speed brake.

For changes in airplane attitude at altitudes where aerodynamic controls are relatively ineffective, the airplane incorporated a ballistic control system, wherein the release of gas (hydrogen peroxide) through small rockets in the nose and wing caused the airplane to move about each axis as required.

Propellants for the rocket engine(s) and associated turbopump(s) – water-alcohol (XLR-11 engines) or anhydrous ammonia (XLR-99 engine), liquid oxygen and hydrogen peroxide – were carried internally.

Engine pneumatic control systems and propellant tanks were pressurized either by helium or nitrogen gas. The airplane pressurization and air conditioning systems used liquid nitrogen and helium.

Two auxiliary power units (APUs) drove the airplane hydraulic pumps and AC electrical generators. They used hydrogen peroxide as a monopropellant.

The X-15 landing gear consisted of a dual wheel nose gear and two main (rear) landing skids. The gear was lowered in flight by gravity and air loads.

The real X-15 was not designed for normal

Xtreme Prototypes X-15A-2 Special Edition, Version 2.0 – Utility Flight Manual
Section 3 — Aircraft Description and Specifications — Page 1

ground takeoff but was air-launched by a modified B-52 bomber. However, unlike the original airplane, the X-15A-2 SE addon can actually take off from the ground in the simulator, like any other aircraft.

THE "ADVANCED" X-15A-2

After the X-15-2 was damaged in 1962, it was rebuilt as a modified "advanced" version of the X-15. The X-15A-2 Special Edition addon for Flight Simulator X and Prepar3D® is a virtual model of the resulting X-15A-2 rocket plane.

The X-15A-2 was rolled out in early 1964. It was especially designed to attain hypersonic velocities in the range of 8000 feet per second at an altitude of 100,000 feet.

The obvious modifications are the addition of a 29-inch fuselage extension between the internal liquid oxygen and ammonia tanks and two large external propellant tanks which can be jettisoned and reused. The added propellant permits a longer engine run which results in added velocity.

The X-15A-2 external tanks provide an additional 1053 gallons of anhydrous ammonia and 770 gallons of liquid oxygen which corresponds approximately to an additional 60 seconds of engine burn time.

The fuselage extension provides an optical window and additional space for experimental and instrumentation equipment as well as housing for liquid hydrogen. Other changes include a removable right wing tip, a modified (shorter) lower fixed vertical stabilizer for attachment of experimental equipment such as ramjet test bed engines, an extended landing

gear, a revised canopy with new elliptical windows, a skylight hatch on top of the instrument compartment, extended side fairings to carry more hydrogen peroxide and a helium spherical tank behind the upper vertical stabilizer.

Hypersonic flight generates tremendous amount of heat and a special ablative coating is used to protect the exterior of the X-15A-2 aircraft during special missions. It consisted of the basic Martin MA-25S pink ablator (that was also used on the space shuttle external tank) sealed with the Dow Corning DC90-090 white protective wear layer.

An "eyelid" was designed to protect the left canopy window from being smeared with ablator residue during high speed flight. The eyelid is closed before the acceleration phase and re-opened before landing.

THE (FICTITIOUS) X-15AD-4

The X-15A-2 Special Edition addon package contains three variations of a fictitious delta wing X-15AD-4 aircraft equipped with the XLR-99 rocket engine, rocket engine nozzle extensions, solid rocket boosters, auxiliary vertical stabilizers and a dummy ramjet, based on different proposed configurations for future X-15 airplanes. The rocket boosters would have allowed for a significant increase in altitude (not speed), up to 500,000 feet at a maximum velocity of 8700 feet per second.

AIRCRAFT SPECIFICATIONS

Engines(s)

- One (1) Reaction Motors XLR-99, "throttable" 60,000-pound liquid-fuel turborocket engine

- Two (2) Thiokol "Castor 1", 45,000-pound solid rocket boosters (on fictitious delta wing model only)

Airplane Dimensions

The overall dimensions of the X-15A-2 airplane (in-flight configuration, external drop tanks attached, with gear up and ventral retained) were as follows:

- Length (with ball nose and XLR-99 engine): 51 feet, 11 inches

- Span: 22 feet, 4 inches

- Height: 13 feet, 1 inch

Airplane Gross Weight

The approximate launch gross weight of the airplane (including full internal load, drop tanks and pilot) was approximately 51,600 pounds. However, this could vary a few hundred pounds, depending on the type of instrumentation carried.

Launched with drop tanks:

- Launch: 51,600 lbs.

- Burnout (drop tanks off): 16,500 lbs.

- Landing (drop tanks off): 15,500 lbs.

Launched without drop tanks:

- Launch: 32,250 lbs.

- Burnout: 16,200 lbs.

- Landing: 15,500 lbs.

Launched with solid rocket boosters (on fictitious delta wing model only):

- Launch: 46,840 lbs.

- Burnout (boosters off): 16,600 lbs.

- Landing (boosters off): 15,800 lbs.

Airplane Serial Numbers

- The U.S. Air Force serial number for the X-15A-2 airplane covered by this manual is **AF56-6671**.

- The U.S. Air Force serial number for the fictitious black X-15AD-4 airplane (with delta wing) covered by this manual is **AF68 -18601**.

- The NASA serial number for the fictitious white X-15AD-4 airplane (with delta wing) covered by this manual is **N203NSX**.

HISTORICAL DATA

- **Arrived** at Edwards AFB in February 1964

- **First captive flight:** June 15, 1964

- **First powered flight:** June 25, 1964 — Mach 4.59 at 83,300 feet (pilot: Robert Rushworth)

- **Last flight:** October 3, 1967 (pilot: Pete Knight)

- **Number of flights:** 22

- **Highest Mach number:** Mach 6.7 at 102,000 feet (October 3, 1967; pilot: Pete Knight)

- **Highest speed:** 4520 mph at 102,100 feet (October 3, 1967; pilot: Pete Knight)

- **Highest altitude:** 249,000 feet at Mach 5.03 (August 3, 1966; pilot: Pete Knight)

Figure 3-1

1. Movable Horizontal Stabilizer (2)
2. Wing
3. Upper Speed Brake
4. Movable Upper Vertical Stabilizer
5. Ammonia Tank (internal)
6. 29-Inch Fuselage Extension
7. Liquid Oxygen Tank
8. APU Exhaust Pipe (2)
9. Canopy
10. Elliptical Window (2)
11. Ejection Seat
12. Astronaut-Pilot
13. Main Instrument Panel
14. Engine Timer
15. Static Pitot Tube
16. Ballistic Control System Rocket (8)
17. Ball Nose
18. Nose Gear
19. Nose Gear Door
20. Nose Gear Scoop Door
21. Ram-Air Door (aft of nose gear door)
22. Vane Antenna
23. Radar Antenna
24. Forward Support
25. Vane Antenna
26. External Canopy Emergency Jettison Handle Access Door
27. Side Fairing (2)
28. Left External Drop Tank (liquid oxygen)
29. Right External Drop Tank (ammonia)
30. External Tank Forward Attach Point and Ejector (2)
31. External Tank Rocket Thruster (2)
32. External Tank Attachment Fairing (2)
33. External Tank Aft Attachment Point, Ejector and Sway Brace (2)
34. Lower Speed Brake
35. Main Landing Gear (2)
36. Skylight Hatch
37. Eyelid
38. Retractable Pitot Tube

Figure 3-2

1. XLR-99 Engine
2. Engine Turbopump Exhaust Pipe
3. Engine Drains
4. Liquid Oxygen Prime Drain
5. Liquid Oxygen Jettison Pipe
6. APU and BCS Hydrogen Peroxide Jettison Pipe
7. Ammonia Vent
8. Ammonia Jettison Pipe
9. Ammonia Prime Drain

10. Engine Turbopump Hydrogen Peroxide Jettison Pipe
11. Helium Tank
12. Wing Flap (2)
13. Ammonia Tank Filler
14. External Tank Dump Valve (2) and Explosive Cartridges (4)
15. Liquid Oxygen Vent
16. Skylight Hatch
17. Star Tracker Experiment Equipment
18. Movable Lower Vertical Stabilizer (Jettisonable)
19. Dummy Ramjet

Note: The liquid oxygen tank filler is on the topside of the wing fairing tunnel forward of the left wing root leading edge (not shown).

Figure 3-3

1. XLR-99 Engine Nozzle Extension
2. Aileron (2)
3. Auxiliary Vertical Stabilizer (2)
4. Delta Wing
5. "Castor 1" Solid Rocket Booster (2)
6. Solid Rocket Booster Nozzle (2)

Xtreme Prototypes next-gen addons no longer include 2D panels found in older products. They are replaced by full-3D virtual cockpits.

Full-3D virtual cockpits no longer have low-resolution, flat 2D gauges; they contain fully modeled high-resolution 3D gauges.

You must be in the virtual cockpit view to operate this addon. If your addon appears to have no virtual cockpit, make sure you have selected the **VIRTUAL COCKPIT** view in the simulator, not the (2D) cockpit view. The virtual cockpit is available from the "Views" menu item on your simulation platform's top menu bar or by pressing the "**F9**" key. You can cycle forward or backward the different views with both the "**S**" key and the "**A**" key. You can also select the virtual cockpit as the default cockpit view when configuring your simulation platform.

Note: By default, the addon will switch automatically to the virtual cockpit view when the X-15A-2 SE aircraft is loaded at the beginning of a new flight.

Fully Functional 3D Virtual Cockpits

The X-15A-2 Special Edition v2.0 addon contains three fully functional 3D virtual cockpits, one for each aircraft model. Virtual cockpits allow for a total 3D immersion into the X-15 flying environment.

Each virtual cockpit contains over 1500 parts and 300 custom systems, animated gauges,

switches, levers, light indicators and flight instruments with integrated tooltips (small yellow rectangles with text that appear under the mouse pointer that contain the description of the underlying device).

Each cockpit was meticulously built to conform as closely as possible to the cabin of the real X-15A-2 rocket plane. All levers, sticks, knobs and switches in the cockpit are clickable, including the fully functional circuit breakers on the right console, and can be used to simulate nearly every step and procedure required in a typical X-15 mission. For example:

- Aircraft servicing (all three propellants and gases)

- APU/generator/hydraulic pump operation

- Propellant tank pressurization

- Engine precool and prime

- Turbopump operation

- Rocket ignition sequence

- Monitoring of pressure gauges

- Propellant jettison

Each cockpit contains many instrument panels:

- Main panel with two wing panels (engine and flight instruments and control, electrical and hydraulic instruments and controls, light indicators, cockpit instruments, engine timer, landing gear handle, emergency canopy handle, SAS panel, retractable pitot handle)

- Left console (VPJ control box and lever, flap switch, RAS lights, BCS control stick, engine throttle, speed brake handle, drop tank controls, radio panel, pressure suit controls, left side control box)

- Right console (breaker panel, cooling lever and switches, right control stick, canopy handle)

- Center pedestal (instrumentation control panel, ram-air levers, DC voltmeter)

Cockpit spotlights are attached to the inside of canopy.

Another interesting feature is the possibility to make the canopy "invisible", creating the impression that the aircraft is equipped with a bubble glass canopy. Though not realistic in the case of the X-15, the invisible canopy mode gives the pilot a better outside view, especially during landing. To make the canopy invisible, simply pull (drag with the mouse) the yellow canopy internal emergency jettison handle [32, fig. 5-1] on the instrument panel right wing. Note that the canopy internal emergency jettison handle does not open the canopy. It simply makes it invisible while the simulator thinks it's still on. Try it while in space for a spectacular view of the Earth, the Moon and the stars.

In addition of making the canopy invisible, the engine timer [11, fig. 5-1] (on the middle top section of the main instrument panel) and the seat headrest [1, fig. 4-2] can also be made invisible. To make the engine timer invisible, click the white label [75, figure 5-1] located to the right side of the timer, on the main instrument panel. To make the headrest invisible, click the pilot's chute container [2, fig. 4-2] located in the upper section of the seat.

For more information about how to make the canopy and other parts invisible in the virtual cockpit, refer to "How to Switch Window Types and Configure the VC".

Other 3D virtual cockpit features include:

- Three fully animated control sticks (user-selectable by clicking the handle)

- Fully animated rudder pedals

- Elliptical canopy windows on all models (default)

- Animated eyelid on the left canopy window (with internal lever, on some aircraft)

- Dynamic ablator spills on selected windows (on pink and white models only)

- Optional trapezoidal windows (user-selectable by clicking the fuse on the main panel) for a better outside view from the cockpit

- Detailed canopy cover with floodlights, electrical and antifogging systems, animated valves, electrical wires and nitrogen pipes, animated head restraint and movie camera

- Fully animated 3D attitude indicator (pitch, roll, azimuth)

- Functional windshield heating (antifogging) system, complete with animated valve handles and dynamic frost/fog textures on the windshield

- Detailed ejection seat with animated handles, buttons, armrests, foot restraints, deflectors and oxygen gauge and selector switch (simply click the handles and buttons)

- Modified X-15 radio for use in the simulator (VHF COM1, COM2, ADF, VOR)

- Optional radio-magnetic indicator (user-selectable by clicking the glass on the dynamic pressure gauge [10, fig. 5-1] on the main panel)

- Access to the default (simulator) Garmin 500 GPS unit

HOW TO ACTIVATE THE SWITCHES, BUTTONS AND KNOBS IN THE VC

- Most **2-position switches** can be turned **ON** or **OFF** with a simple left click with the mouse cursor positioned over the switch actuator. In addition, turning the mouse wheel up will turn the switch to **ON**, turning the mouse wheel down will turn the switch to **OFF**.

- **3-position switches** can be turned to their **UP** position from their **MIDDLE** (or neutral) position by turning the mouse wheel up. Turning the mouse wheel down will move the switch actuator down one position at a time (**UP**, **MID**, **DOWN**). Turning the mouse wheel up will move the switch actuator up again one position at a time (**DOWN**, **MID**, **UP**). Single-clicking with the left mouse button has no effect on 3-position switches.

- **Switch guards** can be opened or closed with a simple left click with the mouse cursor positioned over the guard. In addition, turning the mouse wheel up will open the guard, turning the mouse wheel down will close the guard.

- **Push-button switches and circuit breakers** can be activated with a single left click on the center button/plunger.

- Most **levers and handles** can be dragged with the mouse to the desired position. Simply click on the handle with the left mouse button, drag the handle to the desired position, and release the mouse button.

- **Control sticks** cannot be dragged with the mouse because they are synchronized with the movements of your joystick or with the keyboard arrow keys (pitch and roll). Clicking the black handle activates the control stick. By default, the center stick and the right console stick are activated while the left ballistic control stick is deactivated.

- The **rudder pedals** are synchronized with the rotation movement of your joystick or your flight sim pedals.

- **Knobs** can be rotated with the mouse wheel. Turning the mouse wheel up will turn the knob to the right, turning the mouse wheel down will turn the knob to the left. Continuous rotation is possible on some knobs by left or right clicking with the mouse and leaving the mouse button depressed until the knob is set to the desired position.

- The radio frequency units can be changed by left or right clicking the **radio channel selector knob [2-3, fig. 5-8]**. The radio frequency decimals can be changed by turning the mouse wheel up or down while pointing the radio channel selector knob. Continuous rotation is possible by left or right clicking with the mouse and leaving the mouse button depressed until the knob is set to the desired position.

Important

- A wheel mouse is required to actuate the 3-position switches. Refer to "Minimum System Requirements".

- It sometimes occurs that the pilot's viewpoint is adjusted too far back and lays inside the pilot seat's backrest, rendering the switches unclickable. When this happens, simply move your viewpoint forward a little.

- Some switches must be activated in a logical, predetermined order or sequence to function. If not, the switch is simply disabled and will not respond to mouse clicks. If a switch refuses to operate normally, please revise the previous procedures and make sure that all the required steps have been performed in the correct order. These switches are:

    a) The external drop tanks option switch [26, fig. 5.3] on the service panel section of the center pedestal - can only be moved if the vent, pressurization, and jettison lever [11, fig. 5.4] on the left white control box is at **VENT**.

    b) The unlimited fuel option switch [27, fig. 5.3] on the service panel section of the center pedestal - cannot be moved when the engine master switch [63, fig. 5.1] on the main panel is at **ON**.

    c) The igniter-idle switch [53, fig. 5.1] on the main panel - cannot be moved if the engine turbopump is not running.

- **Tooltips** (small yellow rectangles with text that appear under the mouse pointer that contain the description and reading of the underlying device) are integrated in every clickable parts in the cockpit. When the mouse cursor becomes a hand and the tooltip is displayed, the device can usually be activated with the mouse. If the mouse cursor does not change but the tooltip appears, it means that the device cannot be clicked. However, the tooltip still contains useful information.

The tooltip always displays the correct reading of the underlying instrument even if power is not supplied to the instrument and the pointers are indicating zero (or the light is out). This is an indication of electrical power not being supplied to the instrument, or that the breaker affecting the instrument is pulled out, or that the instrument is defective. Also, the tooltip over a switch shows the state of that particular switch (ON/OFF, etc.) only if the switch has no markings on the instrument panel.

Note: If you can't see the tooltips in the virtual cockpit, make sure the "Show cockpit tooltips" option is selected in your simulator's display settings. Refer to "Compatibility, Performance and Settings".

HOW TO MOVE THE PILOT'S VIEWPOINT IN THE VIRTUAL COCKPIT

While the visibility out of the clamshell canopy is surprisingly good, it may be helpful from time to time, and especially during takeoff and landing, to move the pilot's viewpoint in the virtual cockpit. Below are two examples of the pilot's viewpoint being moved to the left for a better view of the runway. The upper image shows the view with the X-15A-2 elliptical windows installed. The lower image shows the view with the standard X-15 trapezoidal windows.

Use the keyboard to move the pilot's viewpoint in the virtual cockpit:

- "CTRL-Backspace" = Move Forward
- "CTRL-Enter" = Move Aft

- "SHIFT-Enter" = Move Up
- "SHIFT-Backspace" = Move Down

- "SHIFT-(left)CTRL-Backspace" = Move Left
- "SHIFT-(left)CTRL-Enter" = Move Right

- "+/-" = Zoom in and Zoom out
- "SHIFT-+ or SHIFT--" = Fine zoom in or zoom out
- "Backspace" = Reset Zoom

Caution

- Do not move the pilot's viewpoint too far aft because you will not be able to click the switches if your viewpoint is behind the seat or the headrest. You can hide the headrest by clicking the pilot's chute container [2, fig. 4-2] in the upper section of the seat.

HOW SWITCH WINDOW TYPES AND CONFIGURE THE VC

The virtual cockpit offers several options that can be set according to user's preferences. These options include selecting which type of windows should be installed, if the engine timer [11, fig. 5-1], the seat headrest [1, fig. 4-2] or the center stick [8, fig. 4-1] should be made invisible, if the re-entry head restraint [8, fig. 4-3] should be extended and if the radio-magnetic indicator should be installed.

In addition, the clamshell-type canopy can be made invisible to simulate a bubble glass canopy. Though not realistic in the case of the X-15, the invisible canopy mode gives the pilot a better outside view, especially during landing.

Switching Window Types

The X-15A-2 SE addon comes with two different window types: the **elliptical** type found on the X-15A-2 and the **trapezoidal** type found on the original X-15. While not realistic in the case of the A2, we thought that some users may prefer the trapezoidal type because it offers more visibility. User can switch between window types by clicking the fuse [74, fig. 5-1] located on the main panel, next to the engine timer. The eyelid on the left elliptical window (on some aircraft) can be opened or closed by dragging the eyelid handle [6, fig. 4-3] on the left side of the canopy.

The images below show the two different window types. Note the closed eyelid in the first image:

nal emergency jettison "T" handle [32, fig. 5-1] on the instrument panel right wing.

Note that the internal canopy emergency jettison handle does not open the canopy. It simply makes it invisible while the simulator thinks it's still on. To open or close/lock the canopy, use the canopy internal handle [26, fig. 4-1] instead.

Note: The canopy also becomes invisible on the external model.

Hiding the Engine Timer

Invisible Canopy Mode

To make the canopy invisible, simply pull (drag with the mouse) the yellow canopy inter-

The user can also select whether the engine timer [11, fig. 5-1], located on top of the main panel, is installed or not. This feature may be helpful during landing, especially if the canopy is made invisible.

To remove the engine timer, click the white label [75, figure 5-1] located to the right side of the timer, on the main instrument panel. Click again to re-install the timer.

The images above show the main panel with the engine timer installed or removed.

Hiding the Seat Headrest

The seat headrest [1, fig. 4-2] can also be re-moved for a better side view from the pilot's seat. To remove the seat headrest, click the pilot chute container [2, fig. 4-2] in the upper section of the seat. Click again to re-install the seat headrest:
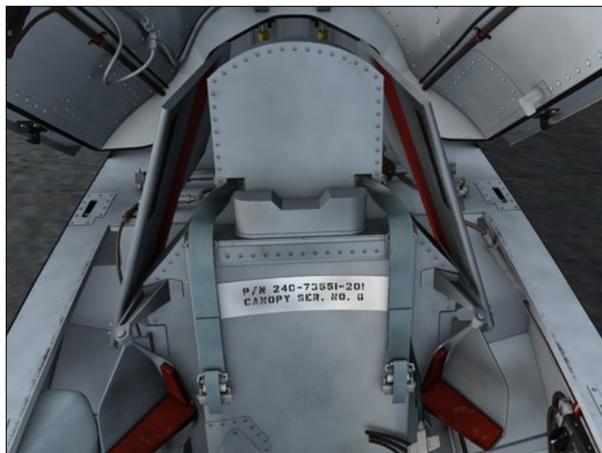
Extending the Head Restraint

The top head restraint [8, fig. 4-3], that is used during re-entry, can be extended or stowed by clicking the yellow front section:

Hiding the Center Stick

The center stick [8, fig. 4-1] can be made in-visible by clicking the center stick boot [9, fig. 4-1]. This gives the pilot a better view of the center pedestal, making the switches and con-trols more accessible. Click again to show the center stick:

Installing the Radio-Magnetic Indicator

An optional radio-magnetic indicator is provided on the center panel. To show/hide the RMI, click the glass in front of the dynamic pressure gauge [10, fig. 5-1], just below the engine timer:

Figure 4-1

1. Main Instrument Panel
2. Engine Timer (Optional)
3. SAS/ASAS/RAS Panel
4. Instrument Panel Left Wing
5. Instrument Panel Right Wing
6. Center Pedestal
7. Ram-Air Lever
8. Center Stick
9. Center Stick Boot
10. Ejection Seat
11. Rudder Pedals
12. Throttle Quadrant
13. Speed Brakes Quadrant
14. Left Console
15. Left White Control Box
16. Ballistic Control Stick
17. Vent, Pressurization, and Jettison Lever
18. Drop Tanks Control Panel (or Rocket Boosters Control Panel)
19. Radio Panel
20. Pressure Suit Controls
21. Left Control Box
22. Retractable Pitot Handle
23. Right Console
24. Breaker and Air Conditioning and Pressurization Panel
25. Pressure Cooling Lever
26. Canopy Interior Handle
27. Right Console Stick
28. Right Console Stick Housing

Figure 4-2

1. Ejectable Headrest
2. Pilot Chute Container
3. Parachute Container
4. Breathing Oxygen Bottles (2, under the seat)
5. Shoulder Harness and Parachute Riser (2)
6. Parachute D-Ring
7. Physiological Instrumentation Cable Receptacle

8. Stabilizing Fin (2)
9. Armrest (2)
10. Ejection Handle and Release Latch (2)
11. Lap Belt Release Pip Pin (2)
12. Personal Leads Disconnect
13. Restraint Emergency Release Handle
14. Foot Restraint Release Button (2)
15. Foot Restraint (2)
16. Deflector (2)
17. Foot Restraint Operating Bar (2)
18. Oxygen Selector and Gauge
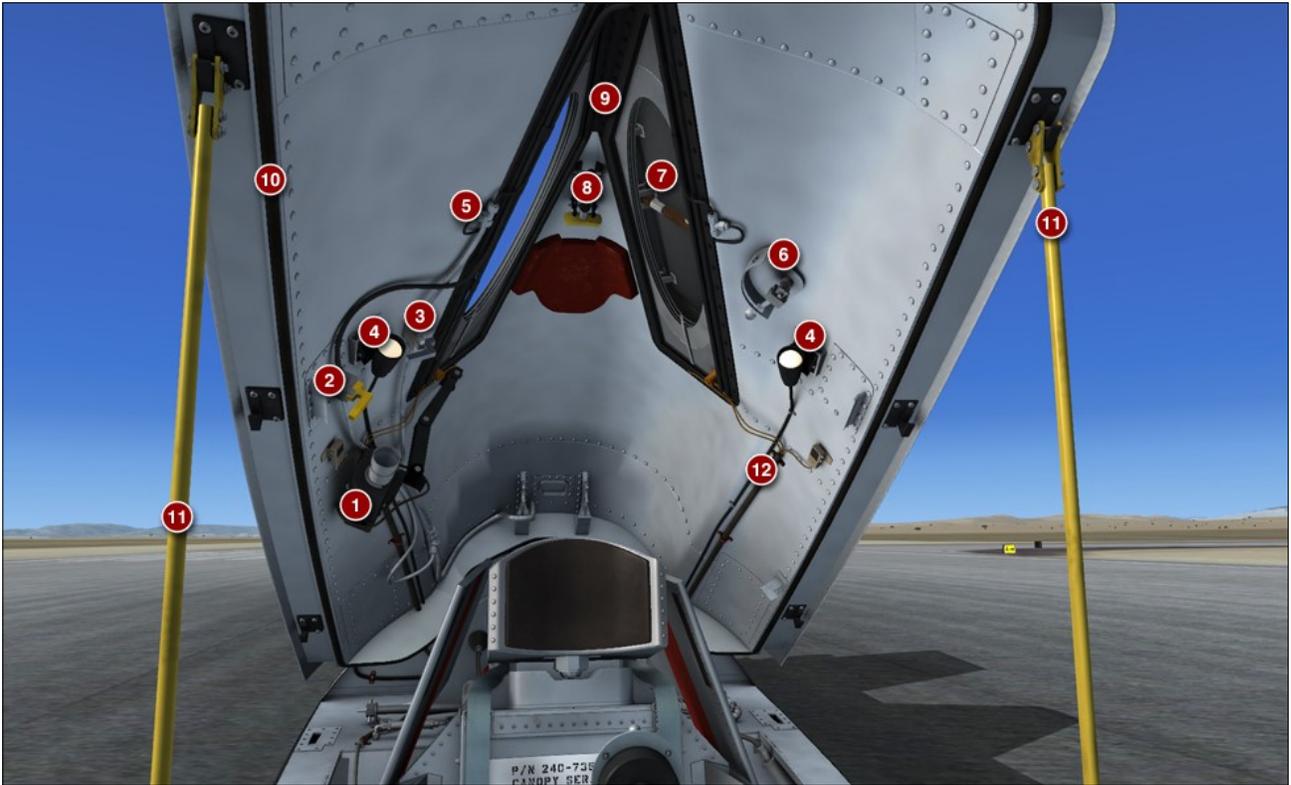
Figure 4-3

1. Movie Camera
2. Windshield Antifogging Valve and Handle
3. Windshield Purge Valve and Handle
4. Cockpit Floodlights
5. Windshield Antifogging and Purge System Tubing
6. Eyelid Handle
7. Eyelid
8. Head Restraint
9. Elliptical Windows or Trapezoidal Windows
10. Canopy Seal
11. Canopy Support Rods
12. Electrical Cables

SYSTEM DESCRIPTIONS

AIRCRAFT SYSTEMS

The following sections contain information pertaining to the real X-15A-2 and/or the X-15A-2 SE v2.0 addon.

The operation of the addon is very similar to the operation of the real aircraft. Some information is provided to better understand the operation of the real aircraft on which the operation of the addon is based. Where modes of operation differ, additional information is provided. We hope you will enjoy learning more about the ingenious systems of the X-15A-2 rocket plane.

Unless otherwise noted, the following systems are simulated to conform as closely as possible to the operation of the real aircraft, within the present limitations and capabilities of the currently available simulation platforms:

- X-15 fuel management system (for the three different types of propellants and gases)
- Service panel
- Engine compartment fire detection system
- Engine turbopump system
- Turbopump hydrogen peroxide system
- XLR-99 power plant propellant and control systems (with some limitations, refer to "About Rocket-Propelled Flight in the Simulator")
- Engine controls and indicators
- Propellant supply system
- Liquid oxygen tank
- Ammonia tank
- Engine and propellant control helium system
- Propellant pressurization helium system
- Drop tank system
- Propellant transfer system (from external drop tanks)
- Solid rocket booster ignition system (delta wing model only)
- Auxiliary power units (APUs)

Figure 5-1

1.   Helium Release Selector Switch
2.   Engine Indicator and Caution Lights (7)
3.   Altimeter
4.   External Tanks Jettison Ready Indicator Lights with Fuel Flow Indicator (Rocket Boosters Jettison Ready Indicator Lights with % Fuel Remaining Indicator on the X-15AD-4)
5.   Airspeed Mach Indicator
6.   Pilot's Oxygen-Low Caution Light
7.   Angle-of-Attack Indicator
8.   Accelerometer
9.   Attitude Indicator
10. Dynamic Pressure Indicator (or Optional Radio-Magnetic Indicator)
11. Engine Timer
12. Delta PSI Switch (Side-Slip Selector Switch)
13. Hydraulic Pressure Gauge
14. Inertial Speed Indicator
15. Inertial Height Indicator

16. Pitch Angle Set Control
17. No. 1 APU Switch
18. No. 1 Ballistic Control Switch
19. Vertical Velocity Indicator (Inertial Climb Indicator)
20. No. 1 Generator-Out Light
21. No. 1 Generator Switch
22. Generator (AC) Voltmeter
23. Emergency Battery Switch
24. Hydrogen Peroxide Transfer Switch
25. No. 2 Generator-Out Light
26. No. 2 Generator Switch
27. No. 2 Ballistic Control Switch
28. No. 1 and No. 2 APU Hydrogen Peroxide Overheat Warning Lights
29. No. 1 and No. 2 APU Compartment Over-heat Caution Lights
30. No. 2 APU Switch
31. No. 1 and No. 2 APU Hydrogen Peroxide-Low Caution Lights
32. Canopy Internal Emergency Jettison Han-

Figure 5-1 (cont'd)

dle (Show/Hide Canopy)
33. Stable Platform Power Switch
34. Nose Ballistic Rocket Heater Switch
35. Ventral Arming Switch (or Dummy Ramjet Arming Switch)
36. Windshield Heater Switch
37. Fire-Warning Light Test Button
38. Indicator, Caution, and Warning Light Test Switch
39. Cockpit Lighting Switch
40. Cabin Helium Source Pressure Gauge
41. Cabin Pressure Altimeter
42. Mixing Chamber Temperature Gauge
43. APU Bearing Temperature Gauge
44. APU Hydrogen Peroxide Tank Pressure Gauge
45. APU Source Pressure Gauge
46. Clock
47. Fire-Warning Light
48. SAS, ASAS, and RAS Controls and Indicator and Caution Lights
49. Rate-of-Roll Indicator
50. Chamber and Stage 2 Igniter Pressure Gauge
51. Propellant Manifold Pressure Gauge
52. Ready-to-Launch Switch
53. Igniter Idle Switch
54. Turbopump Idle Button
55. H_2O_2 Tank and Engine Control Lines Pressure Gauge

56. Engine Prime Switch
57. H_2O_2 Source and Purge Pressure Gauge
58. H_2O_2 Compartment Hot Caution Light
59. Jettison Stop Switches
60. Auxiliary Launch Switch
61. Engine Precool Switch
62. Engine Reset Button
63. Engine Master Switch
64. Fuel Line-Low Caution Light
65. Landing Gear Handle
66. Ammonia Tank Pressure-Low Caution Light
67. Ventral Jettison Button (or Dummy Ramjet Jettison Button)
68. Propellant Emergency Pressurization Switch
69. Propellant Source Pressure Gauge
70. Liquid Oxygen Tank Pressure-Low Caution Light
71. Propellant Tank Pressure Gauge
72. Propellant Pump Inlet Pressure Gauge
73. Skylight Hatch Open Caution Light
74. Panel Fuse (Switch Window Type)
75. Panel White Tag (Show/Hide Engine Timer)
76. Automatic Ignition Sequence Start Button
77. SAS Disengage Switch
78. SAS Power Switch (Basic Autopilot Switch)
79. Data Timer
80. Retractable Pitot Tube Handle
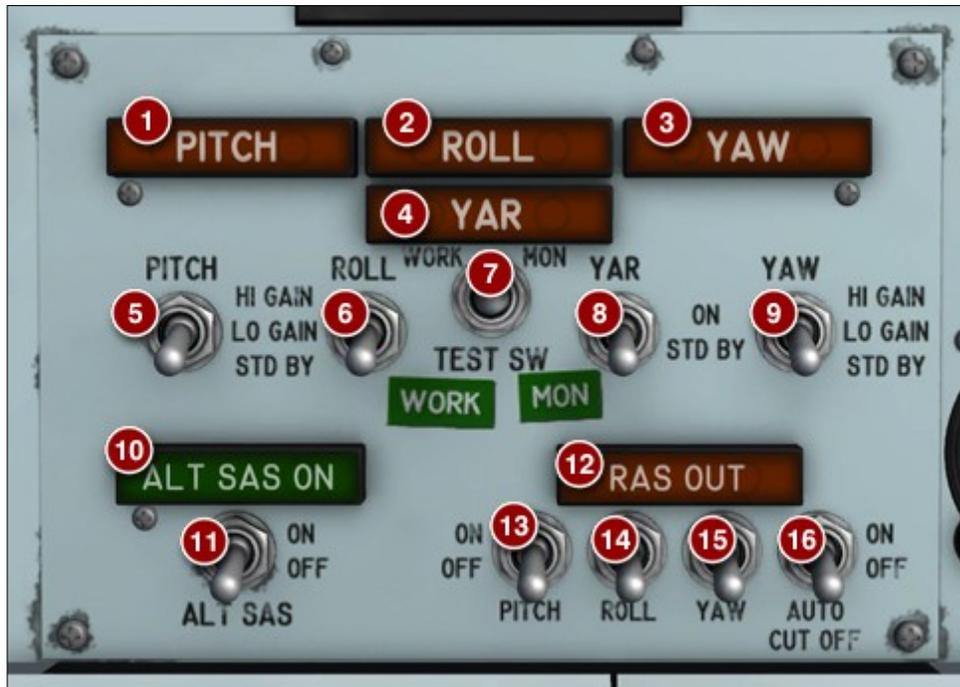
Figure 5-2

1. SAS Pitch Caution Light
2. SAS Roll Caution Light
3. SAS Yaw Caution Light
4. SAS Yar Caution Light
5. SAS Pitch Function Switch (Altitude Hold)
6. SAS Roll Function Switch (Wing Leveler)
7. SAS Test Switch
8. SAS Yar Function Switch (Attitude Hold)
9. SAS Yaw Function Switch (Yaw Damper)
10. Alternate SAS ON Light
11. Alternate SAS Switch
12. RAS-Out Indicator Light
13. RAS Pitch Function Switch
14. RAS Roll Function Switch
15. RAS Yaw Function Switch
16. RAS Automatic Cutoff Switch
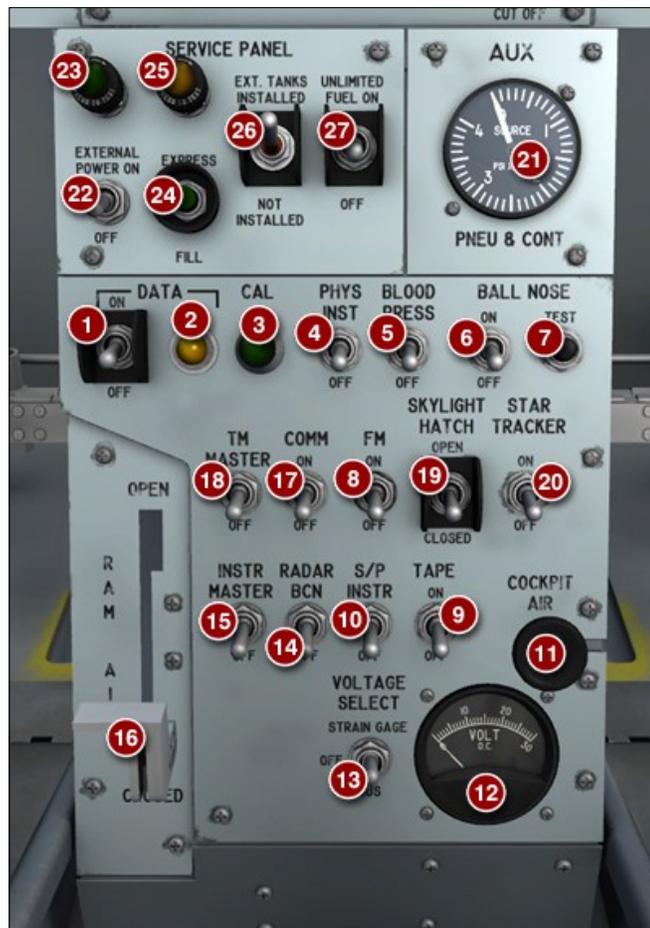
Figure 5-3

1.	Data Switch	16.	Ram-Air Lever
2.	Data Light	17.	Telemeter Commutator Motor Switch
3.	Calibrate Button and Light	18.	Telemeter Master Power Switch
4.	Physiological Instrumentation Switch	19.	Skylight Hatch Switch
5.	Blood Pressure Switch	20.	Star Tracker Power Switch
6.	Ball Nose Power Switch	21.	Auxiliary Pneumatic and Control Pressure Gauge
7.	Ball Nose Test Button	22.	External Power Switch
8.	FM Telemeter Power Switch	23.	External Power ON Light
9.	Tape Recorder Power Switch	24.	Express Fill Button
10.	Stable Platform Instrument Switch	25.	Empty Tank Caution Light
11.	Cockpit Ram-Air Knob	26.	External Tank Option Switch (Rocket Booster Option Switch on the X-15AD-4)
12.	DC Voltmeter	27.	Unlimited Fuel Option Switch
13.	DC Voltmeter Switch		
14.	Radar Beacon Switch		
15.	Instrumentation Master Power Switch		
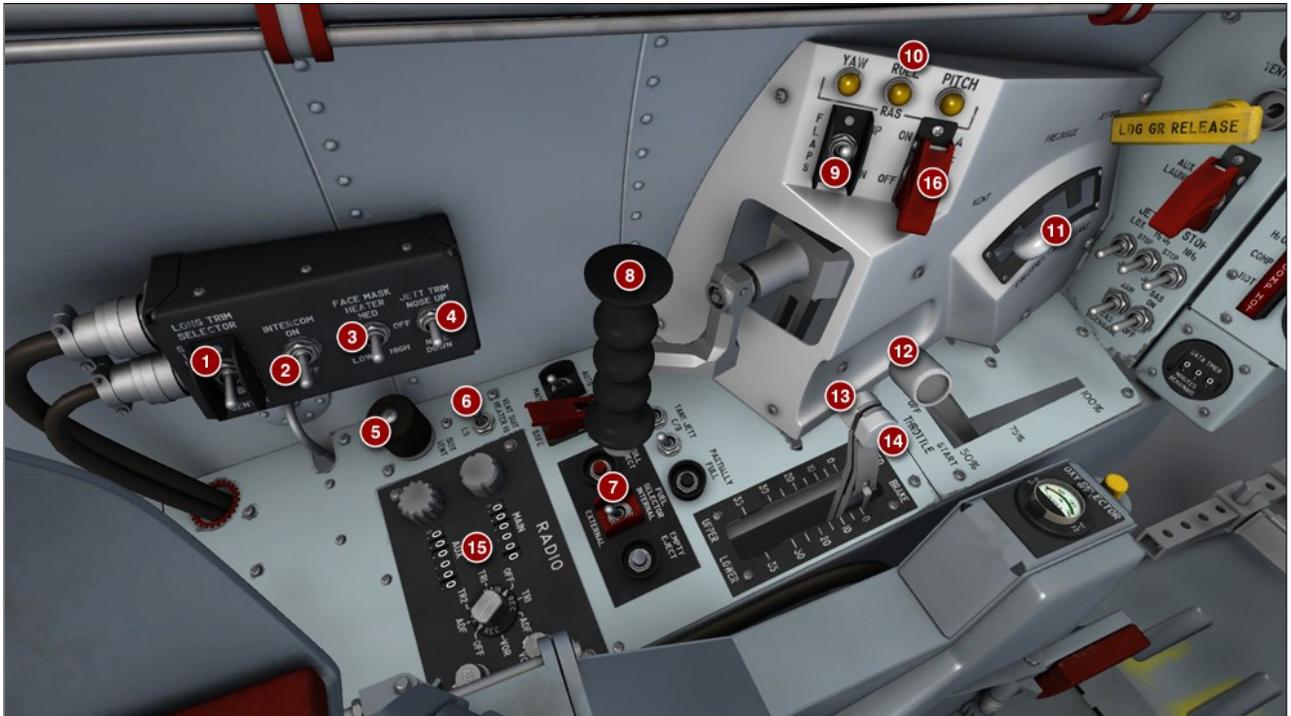
Figure 5-4

1. Trim Control Switch
2. Intercommunication Switch
3. Face Mask Heater Switch
4. Jettison Trim Switch
5. Pressure Suit Ventilation Knob
6. Vent Suit Heater Switch
7. Drop Tanks Control Panel (or Rocket Boosters Control Panel on X-15AD-4)
8. Ballistic Control Stick
9. Wing Flap Switch
10. RAS Yaw, Roll and Pitch Control Indicator Lights
11. Vent, Pressurization, and Jettison Lever
12. XLR-99 Engine Throttle
13. Upper Speed Brake Handle
14. Lower Speed Brake Handle
15. Radio Control Panel (COM, ADF, VOR Controls)
16. Alternate SAS Switch

Figure 5-5

1. Canopy Internal Handle
2. Breaker (and Air Conditioning and Pressurization System) Panel
3. Right Console Control Stick
4. Trim Control Knob
5. Microphone (PTT) Button
6. Horizontal Stabilizer Trim Position Indicator

Figure 5-6

1. Left Tank (Charges) Circuit Breaker
2. Right Tank (Charges) Circuit Breaker
3. External Tanks Jettison Auto-Manual Switch
4. External Tanks Jettison Safe-Arm Switch
5. External Tanks Jettison Full Button
6. External Tanks Jettison Partially Full Button
7. External Tanks Jettison Empty Button
8. Fuel Selector Switch

Figure 5-7

1. Left Booster (Charges) Circuit Breaker
2. Right Booster (Charges) Circuit Breaker
3. Rocket Boosters Jettison Safe-Arm Switch
4. Rocket Boosters Jettison Auto-Manual Switch
5. Rocket Boosters Jettison Button
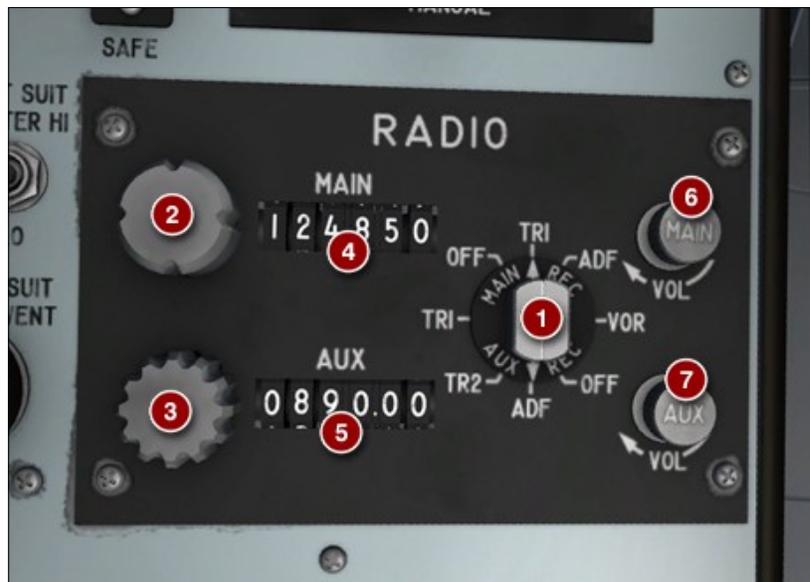
Figure 5-8

1. Radio Function Selector Switch
2. Main Channel Selector Knob
3. Auxiliary Channel Selector Knob
4. Main Channel Indicator Window
5. Auxiliary Channel Indicator Window
6. Main Channel Volume Control
7. Auxiliary Channel Volume Control

Figure 5-9

1. Trim System Circuit Breaker
2. Alternate Trim System Circuit Breaker
3. Rate-of-Roll Indicator Circuit Breaker
4. SAS/RAS Warning Lights Circuit Breaker
5. Ventral (or Dummy Ramjet) Release Circuit Breaker
6. Left and Right Flap Actuators Circuit Breakers
7. SAS Functions Circuit Breakers
8. SAS DC Power Circuit Breaker
9. Pressure-Cooling Lever
10. Blower Switches
11. Cabin Helium Source Shutoff Valve Switch
12. Cabin Helium Source Pressure Gauge Circuit Breaker
13. Hydrogen Peroxide Jettison System Circuit Breaker
14. Fire-Warning System Circuit Breaker
15. Ammonia Jettison System Circuit Breaker

16. Auxiliary Launch System Circuit Breaker
17. APU Nitrogen Cooling Switch
18. No. 1 Blower Circuit Breakers
19. No. 1 Blower Nitrogen System Circuit Breaker
20. No. 2 Blower Circuit Breakers
21. No. 2 Blower Nitrogen System Circuit Breaker
22. No. 1 and No. 2 APU Controls Circuit Breakers
23. No. 1 and No. 2 APU H_2O_2 Jettison Circuit Breakers
24. No. 1 and No. 2 Ballistic Control Systems Circuit Breakers
25. Engine Controls Circuit Breaker
26. Engine Warning Lights Circuit Breaker
27. Alternate Cabin Pressurization Switch
28. Alternate Cabin Pressurization System Circuit Breaker

- Electrical power supply systems (generators, AC/DC power distribution, emergency battery and an external power source)
- Temperature control systems
- Hydraulic power supply systems
- Flight control systems and indicators (vertical and horizontal stabilizers, flaps, speed brakes)
- Launch system
- Landing gear system
- Instruments (pitot static, stable platform)
- BCS, SAS, RAS (limited functionalities, basic simulator autopilot functions replacing SAS; BCS/RAS not currently supported in the simulator)
- Instrumentation system controls and indicators (skylight hatch)
- Indicator, caution and warning light system
- Canopy (with some limitations)
- Ejection seat (with some limitations)
- Air conditioning and pressurization system
- Nitrogen system
- Windshield heating (antifogging) system
- Radio communication and ADF/VOR system
- Cockpit lighting system
- Pilot's oxygen system

Nearly all systems, gauges, switches, light in-dicators and instruments are functional and behave like their original counterparts found in the real aircraft. You can use the tooltips as learning tools for locating the different instruments and switches and memorizing the different panel configurations.

SYSTEM MONITOR PANELS

The X-15A-2 Special Edition addon comes with a system monitor panel that resembles a black and white "mission control" TV screen of the 1960's.

The monitor panel is a 2D panel that can be selected from the "Views/Instrument Panel" menu item on your simulation platform's top menu bar.

The monitor panel provides important additional information about the airplane that is not displayed in the cockpit. You can access the monitor panel at any time to check the status of the different X-15 systems.

The monitor panel is a floating "gauge" that can be undocked and repositioned anywhere on your desktop. It's original size (960 x 720 pixels) is optimized for a display in a standard maximized 1920 x 1200 simulation window

but the panel can be scaled to any size like any other window.

The panel for the X-15AD-4 aircraft is slightly different from the panel for X-15A-2 due to the addition of the two solid fuel rocket boosters.

Below are images of the system monitor panels. The images are self-explanatory:
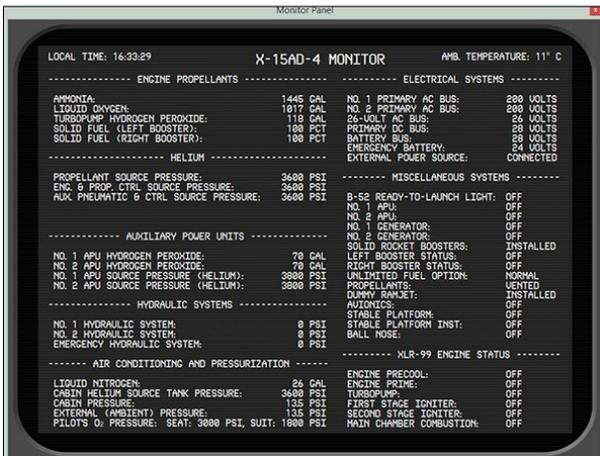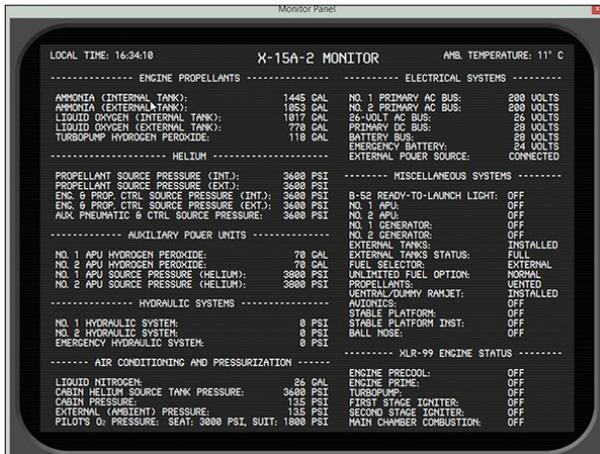
Known Issue (FSX/FSX Steam® and Prepar3D® v1)

- The font used in the system monitor panel may appear jagged under DirectX® 9 in FSX/FSX Steam® and Prepar3D® v1. This seems to be a minor simulator issue. We don't know of any fix at this time. This is not an issue in Prepar3D® v2 and later.

CUSTOM FUEL MANAGEMENT SYSTEM

Conventional aircraft use only one type of fuel (aviation gasoline or jet fuel). Propellant consumption is automatically calculated and managed by the simulator.

Like the real X-15A-2 rocket plane, the X-15A-2 SE addon uses three different types of propellants, all pressurized by helium:

- anhydrous (waterless) ammonia (NH_3) as the main engine fuel;

- liquid oxygen (LOX) as the oxidizer;

- and hydrogen peroxide (H_2O_2) as a monopropellant for the engine turbopump, the APUs and the ballistic control system.

For this reason, the X-15A-2 addon uses a specially designed three-propellant fuel management system that bypasses the simulator's fuel management system.

This special system requires the "Unlimited fuel" option to be selected in the simulator's

realism settings to work properly:

1. Under "Aircraft" (or "Vehicle") in the simulator's top menu bar, select **REALISM SETTINGS**.

2. On the "Settings – Realism" page, under "Engines", select the **UNLIMITED FUEL** option.

For more details, refer to the recommended settings for your simulation platform.

Important

- **Do not use "CTRL+E" to start the engine** — The simulator's autostart command ("CTRL+E") should not be used to start the X-15A-2 engine. For a quick start, use the automatic ignition sequence start button [76, fig. 5-1], located on the main instrument panel, instead. This is similar to pressing "CTRL+E" with conventional aircraft. However, the red button initiates all X-15A-2 rocket aircraft systems, including the special three-propellant fuel management system.

SERVICE PANEL

In the real world, propellants and gases were loaded onto both the B-52 carrier and the X-15A-2 by ground personnel before each flight. During captive flight (while the rocket plane was attached to the B-52 and gaining altitude), the X-15A-2 internal liquid oxygen tank was topped off from the carrier airplane supply.

To simulate the complex servicing of the X-15A-2 rocket plane, both from the ground and from the B-52 carrier, a simplified (fictitious) service panel is provided.

The service panel is located in the upper section of the center pedestal in the virtual cockpit.

Servicing the X-15A-2 SE addon is achieved by the click of a single button on the service panel. The service panel also includes an external power switch to provide electrical power from an external source before takeoff or launch, an external tanks option switch and an unlimited fuel option switch.

External Power Switch

The service panel, on the center pedestal, provides AC and DC electrical power from an external source to the X-15A-2 SE addon before the APUs can be turned on. This simulates electricity being supplied to the X-15A-2 from a ground receptacle or from the NB-52 carrier.

Moving this two-position switch [22, figure 5-3] to **ON** supplies power from an external source to the X-15A-2. Moving the switch to **OFF** cuts off external power.

External Power Light

Whenever power is applied to the X-15A-2 SE addon from an external source, the green external power light [23, figure 5-3], on the service panel, comes on. The light is powered by the external DC power source.

Note: The press-to-test lights in the cockpit can be tested by pressing (left-clicking with the mouse) the light housing. Left-clicking with the mouse a second time will return the light to its normal operating state.

Express Fill Button

The express fill button [24, figure 5-3], on the service panel, is provided for filling all the tanks in the X-15A-2 SE addon, including the external tanks and rocket boosters, with the necessary propellants, fuel and gases in a single step. The button is powered by the battery bus.

Note: Tanks can only be filled if the vent, pressurize, and jettison lever [11, fig. 5-4] is at **VENT.**

Empty Tank Caution Light

This amber light [25, figure 5-3], on the service panel, comes on whenever one internal or external tank is empty. The light, powered by the primary DC bus, should come off after servicing.

Note: The press-to-test lights in the cockpit can be tested by pressing (left-clicking with the mouse) the light housing. Left-clicking with the mouse a second time will return the light to its normal operating state.

External Tanks Option Switch

An external tanks option switch [26, fig. 5-3], on the service panel, is provided for choosing whether or not the X-15A-2 external drop tanks are installed. The external tanks provide an additional 1053 gallons of anhydrous ammonia and 770 gallons of liquid oxygen which corresponds approximately to an additional 60 seconds of engine burn time.

Make sure this switch is set to **INSTALLED** for true X-15A-2 operation (external tanks on).

The external tanks option switch cannot be set if the propellant tanks are pressurized (vent, pressurize, and jettison lever [11, fig. 5-4] not at **VENT**).

Note: External tanks are emptied when the external tanks option switch is moved to **NOT INSTALLED**, then back to **INSTALLED**. Tanks will need to be refilled (refer to "Express Fill Button" above).

Unlimited Fuel Option Switch

In a typical X-15A-2 mission, a normal burn-out occurs after approximately 90 seconds (no external tanks) to 150 seconds (external tanks installed) of XLR-99 engine operation, after the propellants are exhausted.

Although, by default, it is possible to simulate this condition, an "unlimited fuel" option switch is provided, on the service panel, to allow for unlimited-duration burns. Simply turn the two-position switch [27, fig. 5-3] to **ON** if you wish to use this feature.

Note: As long as the engine master switch [63, fig. 5-1] is set to **OFF**, the fuel consumption can be reset to normal at any time by returning the unlimited fuel option switch to the **OFF** position. The switch position cannot be changed if the engine master switch is set to **ON**.

ENGINE

Thrust is provided by one Reaction Motors XLR-99 "throttable" 60,000-pound liquid-fuel turborocket engine.

For rocket booster operation on the delta wing aircraft included with this addon, refer to "Solid Rocket Booster System (X-15AD-4)".

Principles of Rocket Operation

Heat energy derived from the combustion of fuel and oxidizer at high pressure and temperature is converted into kinetic energy of

motion by expansion of the combustion gases to a lower pressure and temperature through an exhaust nozzle. The fact that the gases are accelerated by their expansion through the nozzle means that force has been exerted on them to speed them up. The reaction to this force, acting on the forward end of the combustion chamber, gives the engine a forward push.

About Rocket-Propelled Flight in the Simulator

At the time of publication, rocket engines were still not supported in either Microsoft® Flight Simulator X or Lockheed Martin® Prepar3D®. Your simulation platform still sees the X-15A-2's XLR-99 engine, and the solid rocket boosters on the X-15AD-4, as jet engines. Rocket-propelled flight is therefore not 100% accurate in the simulator although we tried our best to emulate it as much as we could in the flight model, considering the present limitations. We sincerely hope that all simulation platforms will offer true support for rocket engines (and ballistic control) in the near future.

XLR-99 ENGINE OPERATION

The Reaction Motors XLR-99 is a "throttable" 60,000-pound liquid-fuel turborocket engine.

It has a single thrust chamber, a two-stage, continuous igniter starting system, a turbopump, and a gas generator. Propellants are liquid oxygen and anhydrous (waterless) ammonia, supplied from the airplane propel-

lant system. The engine is of variable-thrust design, capable of operating over the range of 50 to 100 percent of full rated thrust.

The gas generator decomposes a monopropellant fuel, 90 percent hydrogen peroxide (H_2O_2), to provide a high-pressure gas mixture for driving the turbopump, which in turn drives the two centrifugal pumps that supply the propellants to the engine. Upon discharge from the pumps, the propellants are delivered to the two igniters and the thrust chamber where they are burned.

At the first-stage igniter, the oxygen (in gaseous form) and ammonia are mixed and then ignited by three spark plugs. Liquid oxygen and ammonia, meanwhile, also are routed to the second-stage igniter. When the pressure created by the hot gases in the first-stage igniter actuates a pressure switch, propellants are allowed to enter the second stage igniter. Here, the propellants are mixed and ignited by the incoming first-stage gases at greatly increased pressure.

(**Did you know?** The XLR-99 engine's second-stage ignition phase by itself produced 1500 pounds of thrust on the real aircraft.)

When a pressure switch in the second-stage igniter is actuated, propellants are allowed to enter the thrust chamber itself. They are again mixed and ignited by the gases coming from the second stage igniter and build to the tremendous pressures needed for required thrust.
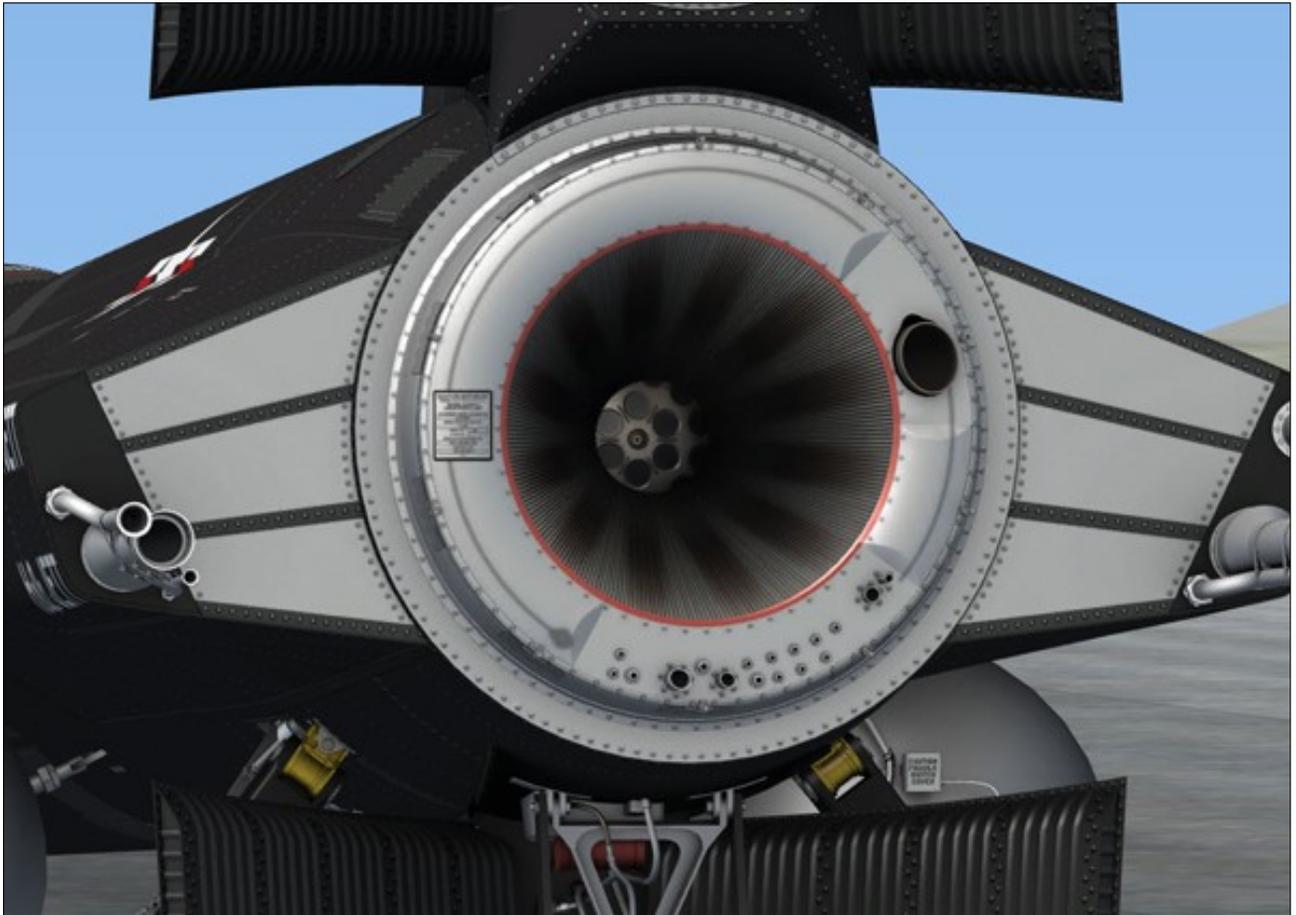
The thrust chamber is an assembly of small welded, wire-wound tubes preformed as segments of the chamber. Before injection into the thrust chamber, the ammonia passes through these tubes to cool the chamber. Exhaust gases are discharged through a venturi-shaped sonic nozzle.

The engine purge system is automatic in operation and uses gaseous helium. It has three functions:

1. To prevent the accumulation of unburned propellants in combustion spaces and engine injectors before engine start and at shutdown;

2. To prevent the reverse flow of combustible mixtures into the liquid oxygen supply system after liquid oxygen runout;

3. To keep the injector and combustion surfaces cool during the igniter idle mode of operation. In this function, nitrogen gas from the carrier airplane is used until

drop; then the switch-over to the self-contained helium system occurs.

During each purge cycle, the engine malfunction system checks the purge system through the combined action of a purge venturi and a purge pressure switch. If the pressure switch indicates an unsatisfactory purge, the engine will not start.

All manual shutdowns are followed automatically by a 5-second purge. However, if an automatic shutdown occurs, because of an engine malfunction or propellant exhaustion, a 20-second purge occurs.

ENGINE COMPARTMENT

The engine compartment, in the extreme aft end of the fuselage, houses the tubular steel engine mount which supports the engine and turbopump.

The engine compartment is completely isolated from the airframe by a mono-firewall. A large access door is provided in the forward end of the engine compartment for access to the engine compartment from the hydrogen peroxide storage tank area.

The engine compartment also houses the instrumentation pick-offs, fire detection system sensors, and helium release line. A fire seal closes out the compartment and protects against the entry of exhaust gases and expelled propellants into the engine compartment.

ENGINE COMPARTMENT FIRE DETECTION SYSTEM

A detection circuit is provided to detect and indicate a fire condition in the engine compartment. This circuit is of the continuous-element type, which detects excessive temperatures anywhere along its length. The sys-

tem is powered by the battery bus and continuously monitors the resistance of the circuit.

The resistance of the material used in the circuit varies inversely with temperature and total length of the sensing circuit. Whenever temperatures in the engine compartment reach 1100°F (594 °C) or higher, the resistance of the sensing element falls below a preset value because of the excessive temperature, and the warning system is energized.

A placard-type warning light, a system selector switch, and a test switch are in the cockpit (see below).

For emergency procedures in case of a fire-warning indication, refer to "Fire or Explosion" in the Emergency Procedures section.

Fire-Warning Light

An abnormal rise in engine compartment temperature is shown by a placard-type warning light [47, figure 5-1], on the instrument panel. The light is powered by the primary DC bus and has a red plastic cap which shows the word "FIRE" when the light is on. The light may be tested by a push-to-test switch [37, fig. 5-1] on the instrument panel right wing.

Fire-Warning Light Test Button

A fire-warning light and detection circuit test button [37, fig. 5-1] is on the instrument pan-

el right wing. The button is powered by the primary DC bus. When the button is pressed, the fire-warning light [47, figure 5-1] should come on, verifying the continuity of the detection circuit.

ENGINE COMPARTMENT PURGING SYSTEM

The engine compartment can be purged by releasing an inert gas (helium) under pressure into the area to extinguish a fire or relieve an over heat condition.

Three cubic feet of helium is stored in two spherical containers under 3600 psi pressure. The containers are on either side of the engine compartment in the left and right wing root fairing tunnels. Either automatic or manual release of helium can be selected by the pilot. Because of the location of the two containers adjacent to the engine compartment, any high temperature condition in the compartment will affect these containers and create a potential explosion hazard. As the helium is released into the engine compartment, it inhibits any fire condition and at the same time eliminates the explosion hazard.

Note: Helium for purging of the engine compartment (or extinguishing an engine fire) is obtained from the 0.491-cubic-foot bottle (located in the 29-inch fuselage extension) on the X-15A-2 SE addon. Helium pressure in the 0.491-cubic-foot bottle can be monitored on the auxiliary pneumatic and control pressure gauge [21, fig. 5-3] on the center pedestal. For more details, refer to "External Tanks

and X-15A-2 Systems".

Helium Release Selector Switch

This 3-position switch [1, figure 5-1], labeled "HE REL SW", is on the left side of the instrument panel. It permits the pilot to select the type of engine compartment purging (either automatic or manual) in case of a fire indication. The switch is powered by the battery bus.

The **AUTO** position sets up an entirely automatic sequence if a fire occurs in the engine compartment, as indicated by illumination of the fire-warning light [47, figure 5-1]. The engine is shut down, and the helium from the two containers outboard of the engine is jettisoned into the engine compartment to inhibit the fire or overheat condition and to prevent over-pressurization of the containers by extreme temperature increase.

The **OFF** position sets up the fire detection system for illuminating the fire-warning light only, in case a fire occurs. It will then be necessary either to move the switch to **ON** to release the helium into the engine compartment without affecting engine operation, or to move the switch to **AUTO** to release the helium and simultaneously shut down the engine.

Moving the switch to **ON** will release the helium into the engine compartment whenever the battery bus is energized. Once energized, the helium release valve is locked in the jetti-

son position and must be electrically un-locked by ground personnel.

Known Issue

■ Due to software limitations in the simula-tor, fire extinguishing can be performed only once during a flight. The flight should be reset or a new flight initiated for the simulator's extinguisher to re-charge.

ENGINE TURBOPUMP

A turbopump, mounted on the front of the engine, delivers the propellants in the de-sired quantities and at the proper pressures to the engine.

The turbopump contains a gas generator, a two-stage, axial-flow turbine, and two centrif-ugal pumps on a common shaft. Each pump supplies one of the propellants to the engine. The monopropellant for driving the turbine is 90 percent hydrogen peroxide (H_2O_2). An electrohydraulic power servo system governs turbine speed to the selected power require-ment.

TURBOPUMP PROPELLANT H_2O_2 SYS-TEM

The hydrogen peroxide monopropellant (H_2O_2) used to drive the turbopump is con-tained in a 10-cubic-foot spherical supply tank with a capacity of 854 pounds (77.5 US gallons).

A swivel-type pickup feed line allows positive feeding of the monopropellant regardless of airplane attitude. The system includes a com-bination vent, pressure relief, and tank pres-surization valve; a jettison valve; a hydrogen peroxide throttle control metering valve; a safety valve; a shutoff valve; and a gas gener-ator. This system is controlled by switches and a control lever in the cockpit and is put into operation whenever the engine starting sequence is begun.

For a description of these controls, refer to "Engine Controls" in this section.

When the engine is not operating, the tank is vented to atmosphere if the vent, pressuriza-tion, and jettison control lever [11, fig. 5-4] is at **VENT** and control gas is available.

The tank is pressurized with helium control gas, to feed the H_2O_2 to the gas generator, which provides steam power for turbopump operation. Tank pressure can be read from a gauge in the cockpit. Refer to "H_2O_2 Tank and Engine Control Line Pressure Gauge" in this section.

The system also includes a jettison feature that permits the H_2O_2 to be forcibly expelled overboard.

Note: The remaining quantity of turbopump hydrogen peroxide can be monitored on the system monitor panel.

H_2O_2 Compartment-Hot Light

An amber H_2O_2 compartment-hot caution light [58, figure 5-1], on the instrument pan-el, comes on when temperature in the upper area of the turbopump propellant compart-ment reaches 538°C (1000 °F) or when tem-perature in the lower area of the compart-ment reaches 427°C (800 °F). When illuminat-ed, the light reads "H_2O_2 COMP HOT". The light is powered by the primary DC bus and may be tested through the indicator, caution, and warning light test circuit.

Turbopump Speed Control

An electrohydraulic servo system is used as an actuation and reference system between the turbine speed and H_2O_2 flow. Its main components are a power package, a governor, a throttle synchro, a servo amplifier, a governor actuator, and an H_2O_2 throttle control metering valve.

Pressurized oil from an electrically driven hydraulic pump is supplied to the governor and metering valve. When the engine throttle [12, fig. 5-4] (throttle synchro) is moved, the governor speed adjustment lever is set to the desired position by the governor actuator. The speed of the turbopump is sensed by the governor, and the hydraulic pressure balance between the governor and metering valve is adjusted to control peroxide flow into the gas generator.

Decrease or increase of the turbopump speed from that required for the selected thrust causes a hydraulic imbalance between governor and metering valve. As the governor reacts to restore the hydraulic balance, hydraulic pressure to the metering valve is increased or decreased, as necessary, to alter the rate of H_2O_2 flow to the gas generator and thus restore the turbopump to the desired speed.

Hazards of Hydrogen Peroxide

Hydrogen peroxide is a clear, water-like liquid which has a faint bluish cast, when seen in a large quantity, and a sharp, acrid odor. Concentrated hydrogen peroxide, if handled properly, is considered to be no more dangerous than most other corrosive and flammable fuels. However, it is considered a fire hazard, and contact of the solution with any combustible material, including most fabrics, usually results in a spontaneously ignited fire. The fire cannot be smothered because of the oxygen supplied during decomposition. Therefore, water, which dilutes the peroxide and cools the flame, is the only satisfactory fire-extinguishing agent. Other agents, such as caustic and foam, may combine with hydrogen peroxide to form dangerous mixtures.

Normally, hydrogen peroxide is not explosive; however, it has been known to detonate if subjected to a violent shock load or heated to high temperature while confined. Also, vapors over concentrated solutions have been exploded with hot wire.

Concentrated hydrogen peroxide, although not toxic, is a strong oxidizing agent and inorganic irritant. Contact with the skin should be avoided. Its vapor causes irritation to the skin, mucous membrane, and the eyes. If contact with the skin is relatively short, no injury will result beyond a temporary bleaching accompanied by a tingling or burning sensation. Contact for longer periods results in redness and, possibly, blistering. No permanent injury has been observed from exposure of the human skin to hydrogen peroxide.

Inhalation of hydrogen-peroxide vapor may cause extreme irritation and inflammation in the nose and throat and, if prolonged, can produce swelling or accumulation of fluid in the lungs. Exposure for short periods has not caused lasting harm.

Exposure of the eyes to splashes from concentrated hydrogen peroxide may cause injury such as ulceration of the cornea, with resulting blindness. It should be noted particularly that injury to the eyes may not be apparent immediately. Corneal ulceration may appear even a week or more after exposure. It must be realized, however, that vapor will sting slightly and cause watering of the eye, but no real injury.

ENGINE PROPELLANT AND CONTROL SYSTEM

The two propellants, anhydrous ammonia and liquid oxygen, are routed from their respective fuel tanks to the main feed valves, which are operated by helium pressure.
From the main feed valves, the fuel is routed to the turbopump.

The fuels, pressurized by a low-pressure inert gas (helium), flow from the respective tanks to the turbopump. Prime orifices allow propellants to circulate and cool the engine and prime the propellant pumps.

The turbopump begins operation when the hydrogen peroxide supply upstream safety valve and downstream shut-off valves are opened. The H$_2$O$_2$ then flows to a gas generator, where it is converted to a high-pressure gas mixture of superheated steam and oxygen to drive the turbine wheel, which in turn drives the propellant pumps.

The propellants are then supplied to the first-stage and second-stage igniters and to the main thrust chamber. After priming is completed, the turbopump is operating, and the first-stage igniter propellant valve is opened, the liquid oxygen to the first-stage igniter is routed inside the turbine exhaust duct, whose hot gases heat the liquid oxygen and change it to a gaseous state.

The gaseous oxygen and ammonia then enter the first-stage igniter. Three spark plugs in the first-stage igniter fire the fuel and oxidizer mixture. When the pressure switch in the first-stage igniter is actuated, the second-stage igniter start valves open, allowing liquid oxygen and ammonia to flow into the second-stage igniter. First-stage igniter flames ignite the second-stage fuel mixture. Combustion pressure in the second-stage igniter then actuates a switch which signals the main propellant valve to open.

When the main propellant valve opens, fuel and liquid oxygen are injected into the main thrust chamber, where they are ignited by second-stage flames.

Before entering the main thrust chamber, the

ammonia is routed through the chamber tubes in order to cool the main thrust chamber. Opening of the main propellant valve stops the flow of propellants to the prime valves.

Once engine operation has been initiated, thrust output is varied between 50% and 100% according to the engine throttle [12, fig. 5-4] position selected by the pilot.

ENGINE CONTROLS

Engine Throttle

The throttle [12, fig. 5-4] controls thrust output of the engine. The throttle quadrant has three marked positions: OFF, 50%, and 100%. The throttle controls an electromechanical servo system, which includes a synchro transmitter attached to the throttle, a servo amplifier, and an actuator position transmitting synchro linked to the turbopump governor.

Turbopump and first and second-stage igniter operation is accomplished with the throttle at **OFF** (full aft and outboard). During the 30-second idle operation period with the throttle

at **OFF**, the turbopump is automatically maintained at idle speed.

Within 30 seconds after igniter idle operation is begun, the throttle must be moved to **START (50%)** to open the main propellant valves to the main thrust chamber or the start sequence must be terminated. After main thrust chamber operation is begun, movement of the throttle between 50% and 100% will vary engine thrust accordingly.

To start the engine after the normal ignition sequence procedures are performed, simply **left-click the white throttle handle** to move the throttle inboard to **START (50%)**. This will ignite the main thrust chamber.

Drag the handle to the desired level of thrust during normal engine operation. The throttle can also be controlled with the keyboard and/or the joystick.

To shut down the engine, simply move the throttle aft to **50%** then **right-click the white handle** to shut off the engine and move the throttle outboard back to its **OFF** position.

Note: The throttle will not move if not left-clicked first.

Vent, Pressurization, and Jettison Lever

This lever [11, fig. 5-4] controls the pressurization system selector valve. The valve is a manually controlled pneumatic selector valve.

The lever has three positions: VENT, PRESSURIZE, and JETTISON. Simply drag the white lever to the desired position.

With the lever at **VENT**, helium pressure (from the helium pressure control system) is applied to all tank control valves in the propellant system. The pressurization valves close and the vent valves open, venting the H_2O_2, liquid oxygen, and ammonia tanks.

In order to obtain engine operation, the lever must be moved to **PRESSURIZE**, opening the propellant system pressurization valves and closing the vent valves. This allows helium to enter and pressurize the turbopump H_2O_2

supply tank and the liquid oxygen and ammonia tanks.

When the lever is positioned to **JETTISON**, helium pressure is applied to open three jettison valves and pressurize the H_2O_2, liquid oxygen, and ammonia tanks. The three propellants will then begin to dump overboard [5, 8 and 10, fig. 3-2].

Important

- The propellants will not jettison if the jettison stop switches [59, FIG. 5-1] are at **STOP**.

- To pressurize or jettison the propellant in the external tanks on the X-15A-2, the fuel selector switch [8, fig. 5-6] must be at **EXTERNAL**, when the desired function is selected with the vent, pressurization, and jettison lever. The external tanks are vented, regardless of the position of the fuel selector switch, when the vent, pressurization, and jettison lever is moved to **VENT**. For more details, refer to "External Tanks and X-15A-2 Systems".

Jettison Trim Switch

This switch [4, fig. 5-4] is on the left vertical side panel. It has three positions: NOSE UP,

NOSE DOWN, and an unmarked, center off position. The switch is powered by the 28-volt primary DC bus.

With the vent, pressurization, and jettison control lever [11, fig. 5-4] at **JETTISON**, the jettison stop switches [59, FIG. 5-1] in the **JETT** position, and this switch at the unmarked off position, simultaneous jettisoning of H_2O_2, liquid oxygen, and ammonia will occur.

Moving this switch to **NOSE UP** (when nose-down trim is felt) stops the flow of the ammonia.

Moving the switch to **NOSE DOWN** (when nose-up trim is felt) stops the flow of liquid oxygen.

In either case, when the airplane returns to trim, the switch must be released and allowed to return to the unmarked off position.

Jettison Stop Switches

Three jettison stop switches [59, fig. 5-1], on the instrument panel left wing, have a STOP and a JETT position. These switches, powered by the primary DC bus, are normally left in the **STOP** position until the prelaunch cruise portion of the flight.

To perform a test of the turbopump H_2O_2, liquid oxygen, and ammonia jettison system, the vent, pressurization, and jettison control lever [11, fig. 5-4] should be placed at **JETTISON**. The systems then can be tested by placing the switches to **JETT**.
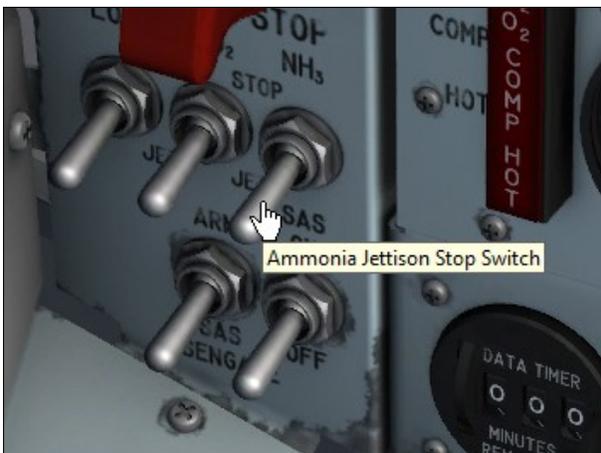
The jettison line of each system should then emit a vaporous cloud. Flow will cease when the switches are returned to the **STOP** position or when the vent, pressurization and jettison control lever is moved to **PRESSURIZE**.

See figure 3-2 for location of jettison, drain, and bleed outlets.

Engine Master Switch

The engine master switch [63, fig. 5-1], on the instrument panel, is powered by the primary DC bus. With the switch at **OFF**, primary DC bus power for engine control and engine indicator lights is interrupted. With the switch at **ARM**, primary DC bus power is applied to the engine indicator lights and engine control switching units.

Engine Reset Button

The engine reset button [62, fig. 5-1], on the instrument panel, is powered by the primary DC bus through the engine master switch [63, fig. 5-1]. For a normal engine start or if a malfunction causes automatic shutdown during any phase of operation, depressing this button positions the engine control circuits to the armed position. However, if the malfunction which caused shutdown persists, engine control circuits will not be armed.

Engine Precool Switch

The engine precool switch [61, fig. 5-1], on

the instrument panel, is powered by the primary DC bus through the engine master switch [63, fig. 5-1]. It has two maintained positions: PRECOOL and OFF (down). With an engine start sequence initiated, moving the switch to **PRECOOL** opens the liquid oxygen main feed valve and precools the system up to the main propellant valve. The precooling flow dumps overboard through the engine liquid oxygen prime valve [4, fig. 3-2].

Note: About 10 minutes is required to precool the engine liquid oxygen system. After precooling is completed, the engine can be maintained in a precooled condition for an extended period by the following schedule: engine precool switch at **OFF** for 20 minutes, then at **PRECOOL** for 7½ minutes, repeating this cycle as often as necessary.

Engine Prime Switch

The engine prime switch [56, fig. 5-1], on the instrument panel, has three positions: an unmarked, maintained center position; a momentary up PRIME position; and a maintained down STOP PRIME position. It is powered by the primary DC bus.

With an engine start sequence initiated, mov-

ing the switch momentarily to **PRIME** opens the liquid oxygen and ammonia main feed valves and the turbopump H_2O_2 upstream safety valve and admits helium to the engine control and purge systems. Approximately 30 seconds is required for priming at high-flow rate, and when the engine precool switch [61, fig. 5-1] is placed at **OFF**, prime continues at low-flow rate until an actual start stops the prime or until the engine prime switch is placed momentarily at **STOP PRIME**.

The priming flow dumps overboard through the engine liquid oxygen and ammonia prime valves [4 and 9, fig. 3-2].

Engine operation may be terminated during any phase by moving this switch to **STOP PRIME**.

Turbopump-Idle Button

The turbopump idle button [54, fig. 5-1], on the instrument panel, is powered by the primary DC bus through the engine master switch [63, fig. 5-1] and the engine reset button [62, fig. 5-1].

With an engine start sequence initiated and the prime phase completed, depressing this button for one second opens the turbopump H_2O_2 downstream shutoff valve, which starts turbopump operation. When pressure of the ammonia in the propellant manifold builds to approximately 210 psi, the turbopump speed control system begins operation and maintains the turbopump at idle speed.

Turbopump exhaust gas can be seen at the back of the airplane when the turbopump is operating [2, fig. 3-2].

Igniter-Idle Switch

This switch [53, fig. 5-1], on the instrument panel, receives power from the primary DC bus through the engine master switch [63, fig. 5-1] and the engine reset button [62, fig. 5-1].

With an engine start sequence initiated and the engine turbopump operating at idle

speed, moving this switch from **OFF** (down) to **IGNITER** (up) causes the following sequence of actions:

- a 2-second helium purge is initiated, and the spark plugs are energized;

- the first stage igniter propellant valves open, and igniter and idle timing starts;

- gaseous nitrogen flow (from the carrier airplane) starts when first-stage igniter pressure reaches a specified value;

- propellants flow to the second-stage igniter;

- second-stage ignition occurs.

Warning

- This phase of operation (igniter idle) is limited to 30 seconds. Either igniter idle operation must be terminated (by placing the engine prime switch [56, fig. 5-1] to **STOP PRIME**) or the launch accomplished at the end of the 30-second idle period.

Note: The igniter-idle switch, in the virtual cockpit, cannot be moved if the engine turbopump is not operating.

AUTOMATIC IGNITION SEQUENCE

The X-15A-2 SE addon can now be started automatically by clicking a single "magic" red button located on the main instrument panel [76, fig. 5-1].

This is similar to pressing "CTRL+E" with conventional aircraft. However, the red button initiates all X-15A-2 rocket aircraft systems, including the special three-propellant fuel management system.

You can use this button to properly start the engine without going through the normal procedures and check list or the quick-start procedures. However, following each step presented in the manual will make your overall X-15 experience much more realistic and enjoyable.

It takes about 60 seconds for the automatic sequencer to perform all the procedures that are required before the engine is fired. Just click the red button, sit back, and watch the switches and gauges in the virtual cockpit while the automatic sequencer executes the normal engine ignition procedures for you.

Note: By default, the sequencer sets the unlimited fuel option switch [27, fig. 5-3] to **ON**. If you prefer a more realistic X-15A-2 flight with a limited engine burn time (about 150 seconds with the external tanks installed), turn the unlimited fuel option switch to **OFF** before the sequencer turns on the engine master switch [63, fig. 5-1] on the main panel. Once the engine master switch is turned on, the unlimited fuel option switch state cannot be changed.

Note: The sequencer will install the external tanks (or the rocket boosters) by default.

Important

- **Do not use "CTRL+E" to start the engine** — The simulator's autostart command ("CTRL+E") should not be used to start the X-15A-2 engine. For a quick start, use the automatic ignition sequence start button instead. Refer to "Custom Fuel Management System".

ENGINE INDICATORS

Propellant Tank Pressure Gauge

This dual-indicating gauge [71, fig. 5-1], on the instrument panel, is powered by the 26-volt AC bus.

The gauge indicates the two propellant tank pressures. The gauge is graduated from 0 to 100 psi in increments of 5 psi. One pointer of the gauge has the letter "L", indicating the liquid oxygen tank pressure; the other pointer has the letter "A", indicating the ammonia tank pressure.

Propellant Pump Inlet Pressure Gauge

This dual-indicating gauge [72, fig. 5-1] is powered by the 26-volt AC bus.

It indicates liquid oxygen and ammonia pressures at the engine turbopump inlets. This gage is graduated from 0 to 100 psi in increments of 25 psi. The pointer labeled "L" reads the liquid oxygen pressure; the pointer labeled "A" indicates the ammonia pressure.

Propellant Manifold Pressure Gauge

This dual-indicating gauge [51, fig. 5-1], on the instrument panel, is powered by the 26-volt AC bus.

The gauge indicates propellant pump discharge pressures. It is graduated from 0 to 2000 psi in increments of 50 psi. One pointer is labeled "L" and indicates liquid oxygen pump discharge pressure; the other pointer is labeled "A" and indicates ammonia pump discharge pressure.

Chamber and Stage 2 Igniter Pressure Gauge

This dual-indicating gauge [50, fig. 5-1], on the instrument panel, is powered by the 26-volt AC bus. The gauge is graduated from 0 to 1000 psi in increments of 20 psi from 0 to 100, and 50 psi from 100 to 1000. The short (red) hand indicates pressure in the second-stage igniter. The long (white) hand indicates pressure in the main thrust chamber.

Ignition-Ready Indicator Light

This green indicator light [2a, fig. 5-1], on the instrument panel, is powered by the primary DC bus through the engine master switch [63, fig. 5-1].

When illuminated, it reads "IGN READY", indicating that the engine electrical circuits and purge gas network have been energized. In the normal starting sequence, this light will go out for 2 seconds when the igniter-idle switch [53, fig. 5-1] is moved to **IGNITER**, then come on again. During all helium purges, this light will go out. This light may be tested by the indicator, caution, and warning light test circuit.
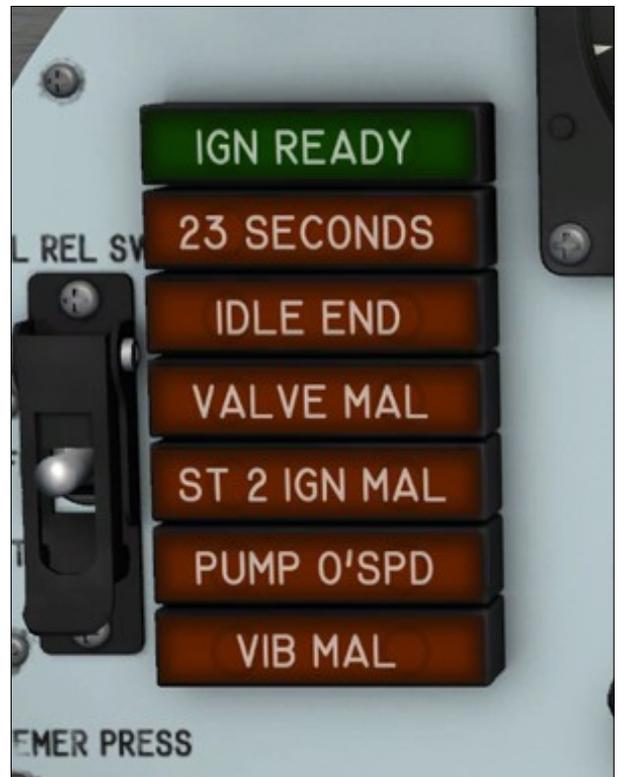
23-Second Caution Light

This amber caution light [2b, fig. 5-1] on the instrument panel, is powered by the primary DC bus through the engine master switch [63, fig. 5-1].

During a normal engine start sequence, this light will come on when 23 seconds of mated igniter idle operation has occurred. Illumina-

tion of the light indicates that a major portion of the nitrogen cooling gas has been used and that launch should be accomplished as soon as possible. The light, when illuminated, reads "23 SECONDS" and serves to warn the pilot to terminate igniter idle operation or to continue on to the launch phase. This light may be tested by the indicator, caution, and warning light test circuit.

Idle-End Caution Light

This amber caution light [2c, fig. 5-1], on the instrument panel, is powered by the primary DC bus through the engine master switch [63, fig. 5-1].

This light will illuminate, reading "IDLE END", when the 30-second igniter idle phase of engine operation is complete. When this light comes on, engine shutdown must be accomplished or operation continued into the main chamber phase (after launch). This light may be tested by the indicator, caution, and warning light test circuit.

Valve Malfunction Caution Light

This amber caution light [2d, fig. 5-1], on the instrument panel, is powered by the primary DC bus through the engine master switch [63, fig. 5-1].

When illuminated, this light reads "VALVE MAL". This light will come on when malfunction shutdown occurs because the main or first stage propellant valve is improperly positioned during the starting sequence. The light will also come on momentarily whenever a malfunction shutdown occurs with the main chamber operating. This light may be tested by the indicator, caution, and warning light test circuit.

Stage 2 Ignition Malfunction Caution Light

This amber caution light [2e, fig. 5-1], on the instrument panel, is powered by the primary DC bus through the engine master switch [63, fig. 5-1].

When illuminated, this light reads "ST 2 IGN MAL". The light will come on when a malfunction shutdown occurs during the starting sequence because of failure of the second-stage igniter to reach operating pressure. The light will also come on momentarily whenever a malfunction shutdown occurs with the main chamber operating. This light may be tested by the indicator, caution, and warning light test circuit.

Vibration Malfunction Caution Light

This amber light [2f, fig. 5-1], on the instrument panel, is powered by the primary DC bus through the engine master switch [63, fig. 5-1].

When illuminated, this light reads "VIB MAL". The light comes on when the engine shuts down because of excessive vibration. Excessive engine vibration causes a shutdown signal to be transmitted from either of two sensors to the engine control box. The signal causes the actuation of two malfunction relays in the control box that de-energize the prime, precool, and firing circuits to shut down the engine and turn on the light. If the light comes on during powered flight, an engine restart may be attempted. This light may be tested by the indicator, caution, and warning light test circuit.

Turbopump Overspeed Caution Light

This amber caution light [2g, fig. 5-1], on the instrument panel, is powered by the primary DC bus through the engine master switch [63, fig. 5-1].

When illuminated, this light reads "PUMP O'SPD." The light will come on if a malfunction shutdown occurs because of turbopump overspeed which is not corrected by the turbopump governor. This light may be tested by the indicator, caution, and warning light test circuit.

Fuel Line Low Caution Light

An amber "FUEL LINE LOW" caution light [64, fig. 5-1] is on the left side of the instrument

panel. This light, powered by the primary DC bus through the engine master switch [63, fig. 5-1], is actuated by a pressure switch installed in the fuel (ammonia) line downstream of the main safety valve.

If fuel pressure at the turbopump inlet drops to 32 (±2) psi, the light will come on. Illumination of the light indicates that partial cavitation of the pump is likely to occur.

When the "FUEL LINE LOW" caution light is on, there is not sufficient cooling around the main chamber of the engine for temperature protection. Thrust settings above 50% may increase the temperature and cause damage to the engine.

If the light comes on before the engine is started, the start will be aborted. When this light has been illuminated, it will remain on until the engine master switch has been placed in the **OFF** position. The light may be tested by the indicator, caution, and warning light test circuit.

Refer to "Fuel Line Pressure Low" in the Emergency Procedures section.

Engine Timer

A special mechanical analog stopwatch [11, fig. 5-1] is installed on top of the main panel

for measuring engine burn time. The timer will start automatically upon ignition of the main thrust chamber and will stop when the engine is shut down. A reset button is provided on top of the timer.

The user can select whether the engine timer is installed or not. This feature may be helpful during landing, especially if the canopy is made invisible. To remove the engine timer, click the white label [75, figure 5-1] located to the right side of the timer, on the main instrument panel. Click again to re-install the timer.

PROPELLANT SUPPLY SYSTEM

The propellant supply system consists of the liquid oxygen supply, anhydrous ammonia supply, valves, and associated plumbing.

The liquid oxygen and ammonia are fed under a low inert gas pressure from the supply tanks to the turbopump for engine operation.

The helium supply systems, which furnish gas pressure for tank pressurization, pneumatic valve operation, and system purging, are described a separate topic.

Note: Frost will appear around the cold propellant tanks of the X-15A-2 SE when filled (LOX, ammonia and external LOX tank).

LIQUID OXYGEN TANK

The liquid oxygen (LOX) supply is carried in a triple-compartmented tank, just aft of the No. 2 equipment compartment.

The center section area of the cylindrical tank is hollow and forms a case for a gaseous helium high-pressure storage tank.

When the liquid oxygen tank is not under pressurization, it is vented to atmosphere.

The tank compartments are check-valve-vented. Each compartment feeds rearward toward the airplane center of gravity. The liquid oxygen is fed from the rear compartment under 48 psi of helium pressure to the turbopump or jettison line through a series

of control valves.

The total volume of the tank is 1034 US gallons; of this amount, 14 gallons is residual at a liquid surface angle of 38 degrees, and 17 gallons is vent and expansion space. The total usable liquid oxygen is 1003 gallons.

The tank is filled for flight through the carrier airplane's supply system. The tank incorporates a liquid oxygen fluid level sensing switch that permits the tank to be topped off automatically whenever fluid drops below a predetermined level. For ground operational checks, the tank is serviced through the receptacle mounted on the engine feed line. The tank filler is on the topside of the wing fairing tunnel forward of the left wing root leading edge.

Note: The remaining quantity of liquid oxygen can be monitored on the system monitor panel.

Hazards of Liquid Oxygen

Liquid oxygen is very pale blue and somewhat less viscous than water. Since the boiling point of liquid oxygen is -297˚ at standard atmospheric conditions, it is constantly evaporating into gaseous oxygen which is colorless and odorless.

Pure oxygen, either in a liquid or gaseous state, does not burn or explode. However, liquid oxygen, when mixed with organic liquids, creates a very sensitive high explosive. Gaseous oxygen will support combustion in a violent manner.

Liquid oxygen is extremely dangerous when spilled in a confined area; the gaseous oxygen produced may remain in relatively high concentration while flowing considerable distances. If an oxygen-fed fire occurs, the only positive way of stopping it is by shutting off the oxygen supply. If this is impossible, large quantities of water may cool the flame enough to extinguish it.

Liquid oxygen mixed with grease, oils, petroleum-derivative fuels, or alcohol, forms a highly impact-sensitive gel which is about equivalent to nitroglycerin in explosive energy. This gel, when formed, has the appearance of a dirty white slush and may be detonated by a spark or flame as well as a mechanical shock. It is, therefore, imperative that a gel, if accidentally formed, should not be disturbed and the area should be evacuated until the liquid oxygen evaporates.

The only physiological hazard to be considered in handling liquid oxygen is the effect of the extreme cold, which destroys living tissue and produces an injury similar to a burn. In addition, freezing can restrict blood circulation and cause gangrene, especially in the extremities. Sufficient liquid oxygen splashed into the eyes will cause blindness.

Gaseous oxygen is not toxic and inhalation has an exhilarating effect.

AMMONIA TANK

The ammonia (NH_3) supply is carried in a triple-compartmented cylindrical tank, just aft of the No. 3 equipment compartment and ahead of the turbopump hydrogen peroxide tank.

The center section area is hollow and closed at both ends. The rear compartment center section is perforated to allow storage of ammonia within the center section area.

The compartments are check-valve-vented. This aids in the pressure feed of the fluid transfer from the rear tank compartment forward toward the airplane center of gravity. The rear compartment empties first; then the middle compartment empties into the front compartment, with the ammonia fed from the front compartment under 48 psi of helium pressure to the turbopump or jettison line through a series of control valves.

The total volume of the tank is approximately 1445 US gallons. The tank is ground-serviced only. The filler receptacle for the tank is on the underside of the right wing root fairing tunnel (marked "Fuel Fill").

Note: The remaining quantity of ammonia can be monitored on the system monitor panel.

Hazards of Anhydrous Ammonia

Anhydrous (waterless) ammonia (NH_3) is formed by the combination of the two gaseous elements, nitrogen and hydrogen. Liquid ammonia is colorless; it boils at a temperature of -28° F at atmospheric pressure and freezes to a white crystalline mass of -107° F. Gaseous ammonia is also colorless and has an extremely sharp, penetrating, pungent, and unpleasant odor.

Concentrated ammonia is both toxic and flammable and must be considered extremely dangerous. It is imperative that all persons handling ammonia be thoroughly familiar with the hazard involved. Although ammonia is sometimes classified as a non-flammable compressed gas, the gas is flammable in air in comparatively high concentrations (16 to 25 percent by volume).

Since ammonia has a penetrating, suffocating odor, and is strongly irritating, it is not likely that a person will voluntarily remain in a contaminated atmosphere. Irritation to the eyes, respiratory tract, and throat results from concentrations as low as 0.05 to 0.1 percent. A concentration of 0.2 percent produces convulsive coughing and may be fatal after an exposure of less than one-half hour. Ammonia gas in a concentration of 0.6 to 1.0 percent volume is lethal within a few minutes. The maximum concentration tolerated by the skin for more than a few seconds is 2 percent. Concentrations on the order of 50 parts per million (0.005 percent) can be detected by the average person.

Ammonia, either as an anhydrous liquid or gas, is a strong irritant, capable of inflicting severe irritation to the surface, tissues of the eyes, nose, throat, and lungs. One of the most hazardous effects of ammonia is its effect on the eyes. When the eye is sufficiently exposed to ammonia, the iris becomes congested and hemorrhaging begins, often resulting in permanent blindness.

In addition to its caustic action, liquid ammonia may cause severe injury to the skin by freezing the tissue. If handled improperly, liquid ammonia can cause irreparable damage, or death.

Canister-type industrial gas masks with full face pieces are adequate protection where ammonia concentration does not exceed 3 percent. For emergencies, or where concentrations exceed 3 percent, a closed-system supplied-air respirator with a full face piece should be used.

ENGINE AND PROPELLANT CONTROL HELIUM SYSTEM

Helium to pressurize the turbopump hydrogen peroxide supply tank and to supply pneumatic pressure for engine and propellant control is contained in four spherical tanks.

One tank is between the liquid oxygen and ammonia tanks. Two tanks are in the left and right wing root fairing tunnels outboard of the engine. These three tanks are interconnected, supplying 3600 psi pressure to two pressure-reducing regulators in parallel.

The fourth tank is just to the right of the turbopump H_2O_2 supply tank and supplies helium at 3600 psi to a single pressure-reducing regulator for emergency or secondary pneumatic control of the propellant jettison valves. This tank is interconnected with the other three tanks for filling purposes only.

From the parallel pressure-reducing regulators of the main supply, helium at 575 to 600 psi is supplied to the engine helium manifold for operation of engine control valves, to the turbopump H_2O_2 supply tank for tank pressurization, and to propellant control jettison and main feed valves.

Two of the tanks supply helium directly to the helium dump valve, for engine compartment purging. The dump valve is solenoid-operated and controlled by the helium release selector switch [1, fig. 5-1]. For information on operation of this switch, refer to "Helium Release Selector Switch" below.

The helium to the engine helium manifold is in turn routed to a control gas valve and the two gas regulators in the purge valve network at a pressure of 550 to 600 psi. The control gas valve is energized during the prime period and admits helium at a pressure of 550 to 600 psi to the pilot valves for the prime valve, first-stage igniter start valve, second-stage igniter start and shutoff valves, and main propellant valve.

Helium at a pressure of 125 to 200 psi is routed from the two purge gas regulators and to the return side of the second-stage igniter start and shutoff valves. Another regulator supplies helium from the helium manifold at 7.5 psi to the lubrication system accumulator, engine control box, and hydraulic power package.

Helium Release Selector Switch

Refer to "Engine Compartment Purging System".

H_2O_2 Source and Purge Pressure Gauge

A dual-indicating H_2O_2 source and purge pressure gauge [57, fig. 5-1], on the instrument panel, is powered by the 26-volt AC bus. This gauge indicates the helium pressure available from three of the engine and propellant helium system tanks.

Needle 1 indicates pressure in the large tank between the liquid oxygen and ammonia tanks. Needle 2 indicates pressure in the two smaller tanks in the wing root fairing tunnels.

The gauge is calibrated from 0 to 4000 psi in increments of 100 psi. Normally, the two pointers will indicate the same pressure. However, if there is a malfunction of the emergency jettison system helium supply or if helium is dumped into the engine compartment, the pointers will not indicate the same pressure. There is no gauge in the cockpit which indicates pressure in the emergency jettison system helium supply tank.

Note: This gauge is modified in the X-15A-2 airplane. Refer to "X-15A-2 Propellant Supply System for details.

H$_2$O$_2$ Tank and Engine Control Line Pressure Gauge

This dual-indicating gauge [55, fig. 5-1], on the instrument panel, is powered by the 26-volt AC bus.

One pointer, labeled "C", indicates engine control line (helium) pressure downstream of the two parallel pressure regulators. The other pointer, labeled "T", indicates pressure in the turbopump H$_2$O$_2$ supply tank.

The gauge is calibrated from 0 to 1000 psi in increments of 50 psi, except that the range 0 to 100 is in increments of 20 psi.

PROPELLANT PRESSURIZATION HELIUM SYSTEM

The propellant pressurization helium system supplies gas to pressurize the liquid oxygen and ammonia tanks.

This helium is contained in the supply tank, within the center section of the liquid oxygen tank and is pressurized to 3600 psi. The helium flows to the normally open pressure regulators of the liquid oxygen and ammonia supply tanks.

The two regulators are actuated by helium pressure (from the engine and propellant helium control system) to the closed position when the vent, pressurization, and jettison control lever [11, fig. 5-4] is at **VENT**. When the control lever is placed at **PRESSURIZE** or

JETTISON, the regulators open and helium pressure flows to the liquid oxygen and ammonia tanks.

The regulators reduce the helium pressure to 48 psi before it enters the liquid oxygen and ammonia tanks.

When the liquid oxygen and ammonia tanks are pressurized, the propellants are forced through the feed lines to the main feed shutoff valves.

Propellant Source Pressure Gauge

The propellant source pressure gauge [69, fig. 5-1], on the instrument panel, is powered by the 26-volt AC bus. The gauge indicates pressure in the cylindrical helium tank for liquid oxygen and ammonia tank pressurization. The gauge is calibrated from 0 to 4000 psi in increments of 100 psi.

Note: This gauge is modified in the X-15A-2 airplane. Refer to "X-15A-2 Propellant Supply System for details.

PROPELLANT EMERGENCY PRESSURIZATION SYSTEM

The propellant emergency pressurization system can be used to pressurize either the liquid oxygen or the ammonia tank in case of a failure in the normal pressurization system. This will permit continued low thrust engine operation or propellant jettisoning.

The emergency system can supply pressurizing gas to only one propellant tank at a time. The emergency system uses helium from the three interconnected tanks in the engine and propellant control helium system.

The system includes a switch and two caution lights.

Note: Failure of the propellant pressurization system is not simulated in this software version.

Propellant Emergency Pressurization Switch

This three-position switch [68, fig. 5-1], on the instrument panel, controls primary DC bus power to the two emergency pressurization system solenoid-operated shut-off valves.

With the switch at **OFF**, the valves are de-energized closed. The switch must be pulled straight out of a détente to move it from **OFF** to either of the other positions.

With the switch at **LOX**, electrical power is applied to open the shutoff valve which controls emergency helium pressure to the liquid oxygen tank. With the switch at **NH$_3$**, electrical power is applied to open the shutoff valve which controls emergency helium pressure to the ammonia tank. All three switch positions are maintained.

Note: Failure of the propellant pressurization system is not simulated in this software version.

Liquid Oxygen and Ammonia Tank Pressure-low Caution Lights

These lights [66 and 70, fig. 5-1], on the instrument panel, are powered by the primary DC bus.

The liquid oxygen tank pressure-low caution light is labeled "LOX". The ammonia tank pressure-low caution light is labeled "NH$_3$". The nomenclature for the lights also serves as position nomenclature for the propellant emergency pressurization switch (see above).

After the vent, pressurization, and jettison control lever [11, fig. 5-4] is placed at **PRESSURIZE**, the related light will come on when pressure in the affected tank drops to 34 (±2) psi.

If a light comes on during powered flight, it may remain on even after emergency pressurization of the affected tank has been initiated, indicating that the affected tank pressure is not above 40 psi.

During the transitional period when the vent, pressurization and jettison lever is moved from **VENT** to **PRESSURIZE**, the lights should come on and remain on for approximately 6 seconds (during build-up of pressure in the propellant tanks).

Note: Failure of the propellant pressurization system is not simulated in this software version.

Hazards of Pressurizing Gases

Nitrogen (N$_2$) and helium (He) are both odorless, colorless gases used for pressurizing rocket-propulsion systems. Helium is chemically inert and nitrogen is chemically inactive. Neither gas is corrosive, explosive, nor combustible.

The only possible hazards arising from the use of either nitrogen or helium stem from (1) high storage and transfer pressures normally employed, or (2) shortage of breathing oxygen because of extremely high concentrations of either gas.

AUXILIARY POWER UNITS

The airplane is equipped with two auxiliary power units (APUs) [8, fig. 3-1] that are set side-by-side in a compartment in the forward fuselage. Each unit is a completely automatic, constant-speed, turbine drive machine that transmits power to, and provides structural support for, an AC generator and a hydraulic pump.

Propellant for each auxiliary power unit is provided by an independent feed system, using helium pressure to move the monopropellant, hydrogen peroxide.

The two auxiliary power units with their respective feed systems are identified as system No. 1 and system No. 2. Their operation is completely independent of each other, and each furnishes one half of the power required. If one unit should fail, the other will provide sufficient electrical and hydraulic power for limited flight capabilities.

Each auxiliary power unit is started and stopped by a switch in the cockpit. When an APU is turned on, a solenoid-type shutoff valve is opened to allow hydrogen peroxide from the propellant feed system to flow into the unit.

The propellant is routed first through a gear case for cooling purposes. Nitrogen gas is also introduced into the gear case to supply a constant 8 to 10 psi pressure to prevent foaming of the gear case lubricant by vacuum at high altitude. In addition, nitrogen gas is

also introduced into the upper turbine bearing area for cooling.

After leaving the gear case, the propellant moves through a flow control valve that is modulated to open or close to provide stabilization through a speed control system consisting of a tachometer generator and a frequency detector. Any turbine overspeed condition is sensed by an overspeed sensing element in the speed control system which will automatically act to close the shutoff valve. When the shutoff valve is closed, fuel flow stops and the unit shuts down. The APU shutoff valve is fitted with a drain that opens when the valve is closed, to relieve any excess pressure in the line downstream of the shutoff valve.

After passing through the flow control valve, the hydrogen peroxide enters a decomposition chamber containing a catalyst bed. This catalyst bed is made up of a series of silver and stainless-steel screens which act to decompose the hydrogen peroxide into a high-pressure gas mixture of superheated steam and oxygen.

(The decomposition chamber is heated electrically from the carrier airplane to ensure a fast start under "cold soak" conditions in case of an emergency.)

The superheated steam and oxygen mixture enters a nozzle box in the turbine housing. Here, five nozzles convert pressure energy of the fluid into kinetic energy and direct the flow of gas against a turbine wheel.

The turbine, acting through a reduction gear train, transmits power to the AC generator and hydraulic pump. The turbine wheel is housed within an exhaust casing which is designed to contain any buckets that might separate from the wheel during an overspeed operation. The exhaust casing collects spent gases that have passed through the turbine wheel and exhausts them overboard.

A gear casing assembly contains the reduction gearing, accessory drive pads, cooling passages, provisions for lubrication, and a drive for the tachometer generator.

For information on nitrogen cooling of the

upper turbine bearing of each APU, refer to "APU Cooling Switch".

APU SPEED CONTROL

The speed control for each auxiliary power unit provides positive speed control, starting and stopping, and overspeed protection by regulating the flow of hydrogen peroxide to the decomposition chamber.

The key component of each speed control is a controller which contains the necessary circuits for sensing unit operation through the frequency output of a tachometer generator. During normal operation, the frequency of the power generated by the tachometer generator, being proportional to the turbine speed, matches a preset frequency of the controller. Any change in turbine speed due to a change in load, or from any other disturbance, causes a proportional change in frequency of the tachometer generator. This frequency change is sensed by the controller, which in turn adjusts the opening of the flow control valve to bring turbine speed back to the normal operating level.

During normal operation, the speed of the unit is automatically controlled to maintain 51,200 rpm by the speed-sensing element of the controller. Should an overspeed condition occur (56,000 rpm or greater), the overspeed sensing element of the controller automatically acts to energize the solenoid-operated APU shutoff valve to the closed position, thereby shutting off the flow of the propellant. The unit then decelerates and stops. It cannot be restarted until the APU switch is first cycled to the **OFF** position.

APU SPEED CONTROL SWITCHES AND LIGHTS

APU Switches

There are two APU switches [17 and 30, fig. 5-1] on the instrument panel, one for control of each auxiliary power unit and its associated feed system.

When either switch is turned to **ON**, battery-

bus power is used to open the helium shutoff valve in the related propellant feed system, allowing helium pressure to move the hydrogen peroxide through the feed lines. At the same time, power is applied to the opening circuit of the related APU shutoff valve. This permits the propellant to flow to the auxiliary power unit.

Turning the switch to **OFF** closes the helium shutoff valve (if the ballistic control switch [18 and 27, fig. 5-1] is at **OFF**), shutting off the helium supply. If the ballistic control switch is at **ON**, the **OFF** position of the APU switch will not close the helium shutoff valve. At the same time, the APU shutoff valve closes, shutting off the flow of the propellant to the unit.

The **JETT** position, powered by the primary DC bus, is used if an emergency arises and it is desired to jettison the propellant overboard. The switch is guarded to prevent it from being accidentally moved to the **JETT** position.

When the switch is turned to **JETT**, the following occurs: The helium shutoff valve in the feed system opens, or remains open if it is already so, allowing the helium to continue to force the hydrogen peroxide through the feed lines. Concurrently, the APU shutoff valve closes and a jettison and ballistic control valve in the feed system opens to the jet-

tison position. The jettison and ballistic control valve serves both as a shutoff valve for propellant supply to the ballistic control system and as a propellant jettison control. As this valve opens to the jettison port, the propellant is routed through a line that dumps overboard [6, fig. 3-2] at the aft end of the airplane.

APU Compartment Overheat Caution Lights

Two APU compartment amber overheat caution lights [29, fig. 5-1] are adjacent to their related APU switches [17 and 30, fig. 5-1] on the instrument panel. The lights are powered by the battery bus.

A thermoswitch in each APU accessory drive compartment is set to energize the light when the temperature in the compartment rises to approximately 525° F. The lights read "APU COMP HOT" when on. If either light comes on, the related auxiliary power unit should be shut down immediately.

APU AND BALLISTIC CONTROL PROPELLANT FEED SYSTEMS

Two completely independent feed systems provide propellant for the auxiliary power units and the ballistic control system.

Note: Ballistic control is not supported in this software version. Refer to "Ballistic Control System".

System 1 is in the left side of the fuselage; system 2 is in the right side of the fuselage. The two systems are identical.

Helium gas under pressure moves the monopropellant hydrogen peroxide to its basic function of providing fuel to these units at the required flow rates and pressures. Each propellant feed system includes a high-pressure, spherical, helium storage tank and a positive expulsion-type hydrogen peroxide storage tank. Both tanks are below the related auxiliary power unit in the forward fuselage.

Helium and hydrogen peroxide filler valves and helium high-pressure gages for ground servicing are in each side of the fuselage side fairings. Helium and hydrogen peroxide pressure gages common to both systems are in the cockpit.

When the ballistic control switch [18 or 27, fig. 5-1] is turned **ON**, or when the APU switch [17 or 30, fig. 5-1] is turned **ON** (or to **JETT**), a shutoff valve is opened to allow helium to flow from the storage tank. The helium tank contains enough helium to expel all the hydrogen peroxide in the hydrogen peroxide storage tank. Helium pressure is reduced from 3600 psi at the tank to 550 psi as it passes through a pressure regulator. A relief valve upstream of the pressure regulator prevents overpressurization due to overcharging or pressure build-up during high-temperature conditions. From the pressure regulator, the helium passes through the shutoff valve and pressurizes the hydrogen peroxide tank.

The positive-expulsion type hydrogen peroxide tank contains a baffle cylinder, perforated to allow the propellant to flow to a pickup tube inside the baffle cylinder. The inlet of the pickup tube is very close to the bottom of

the tank to prevent it from being uncovered during normal flight attitudes when only approximately 20 percent of the propellant supply remains in the tank.

Between the baffle cylinder and tank wall is a collapsible plastic bladder. The helium enters the tank between the wall and the bladder where pressure on the bladder forces the hydrogen peroxide into the baffle cylinder through the pickup tube and out of the tank. A check valve upstream of the tank prevents hydrogen peroxide from backing into the helium system in case of a bladder failure. When the tank is emptied to the extent that the bladder collapses against the baffle cylinder, the feed pressure will drop off. This pressure drop creates a pressure differential between the helium and hydrogen peroxide. When this pressure differential increases to approximately 35 psi, a differential pressure switch in the system actuates a low-level caution light [31, fig. 5-1] in the cockpit.

Pressure differential is also sensed by a valve that opens at approximately 55 psi and allows helium to flow to the top of the baffle cylinder, expelling the remaining hydrogen peroxide.

Protection of the hydrogen peroxide tank against rupture due to overpressurization is provided by a pressure relief valve and a blowout plug. The relief valve is designed to open at approximately 650 psi (100 psi over normal tank pressure). In case of a malfunction of the pressure relief valve or an abnormal rate of pressure increase, the blowout plug will rupture at approximately 900 psi. If the blowout plug should rupture, the affected system will be deactivated by loss of the propellant through the plug. The flow of both of these relief devices is routed overboard through a vent and jettison line [6, fig. 3-2].

A thermoswitch at the base of the tank energizes a warning light [28, fig. 5-1] in the cockpit if the hydrogen peroxide in the tank becomes overheated. From the storage tank, the propellant is routed into feed lines through shutoff valves to the auxiliary power unit and the ballistic control system. Temperature of the propellant at the APU inlet must be a minimum of 40° F during starting. To prevent freezing in the feed lines, warm air

from the carrier airplane is pumped into the compartment containing the propellant feed system hydrogen peroxide components to maintain a temperature of approximately 120° F. The system is designed to dump helium and hydrogen peroxide overboard if an emergency arises.

Note: The remaining quantity of APU hydrogen peroxide can be monitored on the system monitor panel.

APU AND BALLISTIC CONTROL PRO-PRELLANT FEED SYSTEM CONTROLS AND INDICATORS

APU Source Pressure Gauge

A dual-movement helium pressure gauge [45, fig. 5-1], common to both propellant feed systems, is on the right side of the instrument panel. The gauge, labeled "SOURCE", is calibrated in pounds per square inch (psi) and has two pointers, marked "1" and "2" for system identification.

The quantity of H_2O_2 available from the tanks is proportional to source (helium) pressure.

The pressure indicating system is powered by the 26-volt AC bus. Operating pressure will vary from 3600 down to 550 psi, depending upon the helium supply in the stor-

age tank.

APU Hydrogen Peroxide Tank Pressure Gauge

A dual-movement hydrogen peroxide pressure gauge [44, fig. 5-1], common to both propellant feed systems, is on the right side of the instrument panel. The gauge is labeled "H_2O_2" and is calibrated in pounds per square inch (psi). The pointers are marked "1" and "2" for system identification.

The gauge shows tank pressure in the hydrogen peroxide storage tanks, sensed by a pressure transmitter in each feed system. Normal operating pressure is approximately 550 psi.

The pressure indicating system is powered by the 26-volt AC bus.

APU Bearing Temperature Gauge

A dual-pointer APU bearing temperature gage [43, fig. 5-1] is on the instrument panel. The gauge shows in degrees centigrade the temperature of No. 1 and No. 2 APU upper turbine bearings. The temperature indicating system is powered by the No. 1 primary ac bus. The gauge is calibrated from zero to 200 in increments of 20 degrees. The left pointer indicates No. 1 APU upper turbine bearing temperature; the right pointer, No. 2 APU upper turbine bearing temperature.

Hydrogen Peroxide-Low Caution Lights

Each propellant feed system has a low-level caution light [31, fig. 5-1] that reads "H_2O_2 LOW" when on. The two amber, placard-type lights, on the right side of the instrument panel, are powered by the primary DC bus.

A pressure-differential switch in each system becomes energized, causing the related light to come on when the differential pressure between helium and hydrogen peroxide rises to approximately 35 psi. The light will come on at this instant, when approximately 20 percent of the hydrogen peroxide supply is left in the storage tank.

If either light comes on, extreme maneuvers should be avoided to prevent uncovering the inlet of the pickup tube in the tank, thus allowing helium to flow into the hydrogen peroxide line.

Note: During hydrogen peroxide transfer, the hydrogen peroxide low caution light will go out whenever the pressure differential drops below approximately 35 psi.

Hydrogen Peroxide Overheat Warning Lights

The No. 1 and No. 2 hydrogen peroxide overheat warning lights [28, fig. 5-1] are on the right side of the instrument panel. The red, placard-type lights are powered by the battery bus and read "H_2O_2 HOT" when on.

A thermoswitch at the base of each system hydrogen peroxide storage tank energizes the related light if the temperature of the contents of the tank rises to approximately 160° F. If either light comes on, the contents of the affected tank should be jettisoned. Concurrently, the related auxiliary power unit will automatically shut down.

Note: APU hydrogen peroxide tank overheating is not simulated in this software version.

APU Switches

Refer to "APU Speed Control Switches and Lights".

Ballistic Control System Switches

Refer to "Ballistic Control System".

HYDROGEN PEROXIDE TRANSFER SYSTEM

This modified airplane has a transfer system incorporated in the hydrogen peroxide propellant feed systems to provide a means of transferring hydrogen peroxide from the engine turbopump propellant tank to the APU and ballistic control propellant tanks after engine shutdown.

Transfer may be accomplished whenever one or both hydrogen peroxide low caution lights [31, fig. 5-1] come on.

Hydrogen Peroxide Transfer Switch

The hydrogen peroxide transfer switch [24, fig. 5-1], labeled "H$_2$O$_2$ TRANS," is on the upper right side of the instrument panel. It has three positions: ON, OFF, and an unmarked center neutral position.

When the switch is at **ON**, primary DC bus power opens a solenoid-operated transfer valve and allows flow of hydrogen peroxide from the engine turbopump tank to the APU tanks. The switch will return to the spring-loaded center position when released, leaving the valve in the desired position. To stop transfer of hydrogen peroxide, the switch is placed at **OFF**.

ELECTRICAL POWER SUPPLY SYSTEM

The airplane is equipped with an alternating-current (AC) and a direct-current (DC) electrical power system.

Power for the AC system is supplied by two alternator-type generators.

The DC system normally is powered from the AC system through two transformer-rectifiers.

A 24-volt battery is available for use in an emergency to supply DC power to essential equipment.

Note: All voltages can be checked on the system monitor panel.

External Power Source

During ground operation, AC and DC power can be supplied to the airplane by an external power source. During captive flight, the carrier airplane can supply AC and DC power to the airplane. Both external power sources supply minimum DC power for initial relay or valve operation only. Large amounts of DC

power then are supplied from the AC system through the transformer-rectifiers.

External Electrical Power Receptacle

The external power receptacle is on the upper surface of the fuselage, aft of the canopy.

When AC and DC external power is applied to the airplane by a ground unit, an adapter must be used. When external power is applied from the carrier airplane, a single plug-in unit in the carrier airplane pylon is used.

External Power Switch

The (fictitious) service panel, on the center pedestal, provides AC and DC electrical power from an external source to the X-15A-2 SE addon before the APUs can be turned on. This simulates power being supplied to the X-15 from a ground receptacle or from the carrier aircraft. Moving the external power switch [22, figure 5-3] to **ON** supplies power from an external source to the X-15. Moving the switch to **OFF** cuts off external power.

External Power ON Light

Whenever power from an external source is supplied to the X-15, the external power ON (green) light [23, figure 5-3] comes **ON**.

AC ELECTRICAL POWER DISTRIBU- TION

Two AC generators supply 200/115-volt, 400 -cycle, three-phase AC power to the two pri- mary AC busses. Each generator is driven through a gear train by an auxiliary power unit (refer to "Auxiliary Power Units"). Two 26 -volt AC busses are powered by the No. 2 pri- mary AC bus. Automatic frequency control and voltage regulation are provided for the AC generators.

AC Generators

Each AC generator is driven through a gear train by an auxiliary power unit and supplies 200/115-volt, 400- cycle, three-phase AC power to its respective primary AC bus. Fail- ure of an APU causes failure of the AC gener- ator it drives. If one AC generator fails for any reason, the other AC generator automati- cally supplies power to both primary AC bus- ses. If either generator drops "off the line" because of a momentary malfunction, it can be reset "onto the line".

Primary AC Busses (200 volts)

The No. 1 primary AC bus normally is pow- ered by the No. 1 AC generator; the No. 2 primary AC bus, by the No. 2 AC generator. However, if either generator fails, the remain- ing generator will power both primary AC busses. External power, on the ground or from the carrier airplane, will power the pri- mary AC busses, but only when neither AC generator is on.

26-Volt AC Busses

The two 26-volt AC busses are powered through two parallel transformers by the No. 2 primary AC bus. The 26-volt busses are powered as long as either AC generator is operating. In addition, when external power is applied to the airplane on the ground or from the carrier airplane (and both AC gener- ators are off), the 26-volt busses are pow- ered.

DC ELECTRICAL POWER DISTRIBU- TION

Direct-current power is distributed from the 28-volt primary DC bus and the battery bus.

28-Volt Primary DC Bus

The 28-volt primary DC bus is powered by both primary AC busses through two trans- former-rectifiers.

The primary DC bus, in addition to powering certain equipment, normally powers the bat- tery bus. Failure of one AC generator will not de-energize the primary DC bus. The primary DC bus also is energized when external pow- er is applied on the ground or from the carri- er airplane.

Battery Bus

The battery bus normally is powered by the primary DC bus. However, the emergency battery can be connected to the battery bus to provide emergency DC power. In addition, external power on the ground or from the carrier airplane can be applied to the battery bus.

Emergency Battery

A stand-by, 24-volt, emergency battery is available to provide emergency power to the battery bus.

ELECTRICAL POWER SUPPLY CON- TROLS

No. 1 Generator Switch

A three-position switch [21, fig. 5-1] on the instrument panel controls operation of the No. 1 AC generator by means of battery bus power. The switch is spring-loaded from the RESET position to ON. When the switch is **OFF**, the generator is taken "off the line". When the generator is "off the line", because the switch is at **OFF** or because of a momen- tary generator malfunction, the switch must

be moved to **RESET** momentarily to bring the generator "on the line" and then released to **ON** to maintain the generator "on the line".

Note: Neither generator will operate unless the APU for the respective generator is also operating and driving the generator.

To bring the No. 1 generator "on the line" initially, the switch must be moved from **OFF** to **RESET** momentarily and then released to **ON**. It is not necessary to move the switch to **OFF** when the No. 1 APU is shut down, because the No. 1 generator underfrequency protective relay will have tripped the generator off.

Note: If either generator is operating and "on the line", most external power is automatically disconnected. Power to the battery bus, certain heaters, ready-to-launch light, liquid oxygen level probe, and stabilization of stable platform remains on.

No. 2 Generator Switch

Switch positions and operation of this switch [26, fig. 5-1], on the instrument panel, are identical to those for the No. 1 generator control switch, except that, obviously, the No. 2 switch controls the No. 2 generator.

Emergency Battery Switch

This guarded, two-position switch [23, fig. 5-1], on the instrument panel, controls connection of the emergency battery to the battery bus. Normally, the switch is in the guarded **OFF** position. Raising the guard and moving the switch to **ON** connects the emergency battery directly to the battery bus.

DC Voltmeter Switch

This three-position switch [13, fig. 5-3], on the center pedestal, allows strain gauge or primary DC bus voltage to be monitored. When the switch is at **OFF**, the DC voltmeter [12, fig. 5-3] is disconnected. Moving the switch to **STRAIN GAGE** connects the DC voltmeter to the strain gauge power. When the switch is at **BUS**, the voltmeter is connected to the primary DC bus.

Note: Strain gauges (and sensors) are not simulated in this software version. However, the DC voltmeter will indicate 24 volts when the switch is at **STRAIN GAGE**, indicating a normal strain gauge circuit.

ELECTRICAL POWER SUPPLY SYSTEM INDICATORS

AC Generator Voltmeter

A dual indicating AC voltmeter [22, fig. 5-1], on the instrument panel, shows No. 1 and No. 2 generator voltages. The instrument has a range of 0 to 250 volts, graduated in increments of 20 volts. The voltmeter reads line-to-line, rather than line-to-neutral or line-to-ground. Thus, the reading under normal conditions should be 200 volts and would check availability of two phases rather than only one phase.

When both primary AC busses are energized by one generator or by external power, both pointers should indicate the same voltage. If either generator fails, both pointers will show the output of the remaining generator.

No. 1 Generator-out Light

Whenever the No. 1 generator drops "off the line", the amber No. 1 generator-out caution light [20, fig. 5-1], on the instrument panel, comes on and reads "GEN OUT". The light is powered by the 28-volt primary DC bus.

No. 2 Generator-out Light

Whenever the No. 2 generator drops "off the line", the amber No. 2 generator-out caution light [25, fig. 5-1], on the instrument panel, comes on and reads "GEN OUT". The light is powered by the 28-volt primary DC bus.

DC Voltmeter

The DC voltmeter [12, fig. 5-3], on the center pedestal, has a range of 0 to 30 volts, graduated in increments of one volt. This voltmeter will indicate either primary DC bus or strain gauge power voltage. The voltage reading selection is through the DC voltmeter switch [13, fig. 5-3].

Note: Strain gauges (and sensors) are not simulated in this software version. However, the DC voltmeter will indicate 24 volts when the DC voltmeter switch is at **STRAIN GAGE**, indicating a normal strain gauge circuit.

CIRCUIT BREAKERS AND FUSES

The electrical distribution circuits are protected by circuit breakers and fuses on the electrical power panel in the No. 2 equipment compartment and on the circuit breaker panel [2, fig. 5-5] on the right console in the cockpit.

All of the circuit breakers on the right console panel are of the push-pull type. The circuit breakers in the No. 2 equipment compartment must be properly positioned before carrier take-off, because they are not accessible in flight.

Cockpit Circuit Breakers

These circuit breakers are located on the

right console in the cockpit. They are self-explanatory:

- Trim System Circuit Breaker [1, fig. 5-9]

- Alternate Trim System Circuit Breaker [2, fig. 5-9]

- Rate-of-Roll Indicator Circuit Breaker [3, fig. 5-9]

- SAS/RAS Warning Lights Circuit Breaker [4, fig. 5-9]

- Ventral (or Dummy Ramjet) Release Circuit Breaker [5, fig. 5-9]

- Left and Right Flap Actuators Circuit Breakers [6, fig. 5-9]

- SAS Functions Circuit Breakers [7, fig. 5-9]

- SAS DC Power Circuit Breaker [8, fig. 5-9]

- Cabin Helium Source Pressure Gauge Circuit Breaker [12, fig. 5-9]

- Hydrogen Peroxide Jettison System Circuit Breaker [13, fig. 5-9]

- Fire-Warning System Circuit Breaker [14, fig. 5-9]

- Ammonia Jettison System Circuit Breaker [15, fig. 5-9]

- Auxiliary Launch System Circuit Breaker [16, fig. 5-9]

- No. 1 Blower Circuit Breakers [18, fig. 5-9]

- No. 1 Blower Nitrogen System Circuit Breaker [19, fig. 5-9]

- No. 2 Blower Circuit Breakers [20, fig. 5-9]

- No. 2 Blower Nitrogen System Circuit Breaker [21, fig. 5-9]

- No. 1 and No. 2 APU Controls Circuit Breakers [22, fig. 5-9]

- No. 1 and No. 2 APU H_2O_2 Jettison Circuit Breakers [23, fig. 5-9]

- No. 1 and No. 2 Ballistic Control Systems Circuit Breakers [24, fig. 5-9]

- Engine Controls Circuit Breaker [25, fig. 5-9]

- Engine Warning Lights Circuit Breaker [26, fig. 5-9]

- Alternate Cabin Pressurization System Circuit Breaker [28, fig. 5-9]

Important

- These breakers are fully functional in the X-15A-2 SE addon. The circuit is closed when the breaker is pushed in. The circuit is open when the breaker is pulled out. Make sure all breakers are pushed in for proper aircraft operation.

HYDRAULIC POWER SUPPLY SYSTEMS AND INDICATORS

The airplane has a No. 1 and a No. 2 hydraulic system and an emergency hydraulic system. The No. 1 and No. 2 systems are independent, but operate simultaneously to supply hydraulic pressure to all hydraulically-operated systems of the airplane.

Fluid is supplied to each hydraulic system by a reservoir, and pressure for each system is maintained by a variable high-displacement pump and a constant low-displacement pump. Each pump is driven through a gear train from the APU (refer to "Auxiliary Power Units").

The hydraulic system No. 1 pump is driven by APU No. 1; the system No. 2 pump is driven by APU No. 2.

The hydraulic systems supply power for operation of the aerodynamic flight control system, speed brakes, and wing flaps.

Known Issue (FSX, Prepar3D® v1)

- Due to some limitations in FSX and Prepar3D® v1, it is possible to observe the movement of the control surfaces, including the speed brakes, without the APUs operating and providing hydraulic power to the motors. Of course, this was not possible on the real aircraft. Fortunately, this is no longer an issue in Prepar3D® v2 and later.

Dual, tandem hydraulic actuators are used, so that failure or shutdown of one hydraulic system will still permit the other hydraulic system to operate the various units. Each hydraulic actuator is capable of holding half of the maximum design hinge moment during single-system operation, which is adequate for control and landing of the airplane.

The SAS pitch-roll servo cylinders are powered by the No. 2 hydraulic system. The SAS emergency hydraulic system will provide pressure to the pitch-roll servo cylinders in case of No. 2 system failure or shutdown of APU No. 2. The stability augmentation system yaw servo cylinder is powered only by hydraulic system No. 1. The No. 1 or No. 2 hydraulic system is automatically in operation whenever its respective APU is operating.

Emergency Hydraulic System

The emergency hydraulic system provides hydraulic power for the SAS pitch-roll servo cylinders in case of failure of the No. 2 hydraulic system or its related APU. The 3000 psi system consists of a hydraulic motor, powered by the No. 1 hydraulic system, which drives a variable-displacement, con-

stant-pressure hydraulic pump. A pressure-operated selector valve directs No. 1 hydraulic system pressure to the hydraulic motor in case of No. 2 system failure. The emergency system has its own reservoir.

Note: Emergency hydraulic system pressure can be monitored on the system monitor panel.

Hydraulic Pressure Gauge

A dual-movement, synchro-type gauge [13, fig. 5-1], on the instrument panel, indicates pressure in the No. 1 and No. 2 hydraulic systems. There are two pointers, numbered 1 and 2, for indicating respective system pressure. The gauge has a range of 0 to 4000 psi in increments of 100 psi. The pressure indicating system receives power from the 26-volt AC bus.

FLIGHT CONTROL SYSTEMS

The X-15 has two control systems: The aerodynamic flight control system and the ballistic control system.

The aerodynamic flight control system consists of a mechanical system including hydraulically-actuated control surfaces for use at altitudes where these surfaces are effective for maneuvering the airplane.

The ballistic control system is used to control the airplane attitude at altitudes where the aerodynamic surfaces are relatively ineffec-tive. The ballistic control system uses a monopropellant (H_2O_2) which is released through rockets at high velocity to rotate the airplane about its pitch, roll, and yaw axes as required for re-entry, and to correct oscillation.

Note: At the time of publication, ballistic control for rocket airplanes was still not supported in either Microsoft® Flight Simulator X or Lockheed Martin® Prepar3D®. Because aerodynamic control surfaces become less and less effective above about 125,000 feet in the simulator as dynamic pressure decreases, we recommend flying the X-15A-2 SE addon below 200,000 feet. Refer to "Ballistic Control System" for more details.

AERODYNAMIC FLIGHT CONTROL SYSTEM

The X-15 aerodynamic flight control system incorporates hydraulically actuated yaw and pitch-roll control surfaces. The irreversible characteristics of the hydraulic system hold the control surfaces against any forces that do not originate from pilot control movement and prevent these forces from being transmitted back to the pilot controls. Thus, aerodynamic loads of any kind cannot reach the pilot through the controls.

An artificial-feel system is built into the control system to simulate feel at the pilot controls. In-flight trimming in pitch is accomplished by changing the neutral (no-load) position of the artificial-feel system and repositioning the control sticks.

Yaw control is provided by movable upper [4, fig. 3-1] and ventral vertical stabilizers [17, fig. 3-2].

The left and right horizontal stabilizers [1, fig. 3-1] provide pitch and roll control, simultaneous operation for pitch control, and differential operation for roll control. An assist to the aerodynamic damping in pitch, roll, and yaw is provided by a stability augmentation system (SAS).

Known Issue (FSX, Prepar3D® v1)

- Due to some limitations in FSX and Prepar3D® v1, it is possible to observe the movement of the control surfaces, including the speed brakes, without the APUs operating and providing hydraulic power to the motors. Of course, this was not possible on the real aircraft. Fortunately, this is no longer an issue in Prepar3D® v2 and later.

Flight Control Hydraulic Systems

When both hydraulic systems fail, the aerodynamic control surfaces will remain in the position at which failure occurred. However, the surfaces may be moved in the direction in which they are driven by aerodynamic loads by repositioning of the pilot controls in the direction to streamline the surface. The pedals [11, fig. 4-1], center stick [8, fig. 4-1], and console stick [3, fig. 5-5] are mechanically linked to the control valves on their respective actuators. Movement of a pilot control results in corresponding movement of its actuator control valve. As the actuator moves, the control valve is repositioned to a neutral position so that flow to the actuator is shut off. The pressure remaining in the actuator serves to hold the control surface in the desired position. Control cable rig tension is maintained throughout a wide temperature and deflection range by thermal expansion and contraction tension regulators.

Artificial-Feel and Trim Systems

The artificial-feel system ("force feedback" in the simulator) gives a sense of control feel to the pilot under all flight conditions where the aerodynamic controls are used. Aerodynamic stick [8, fig. 4-1] and rudder pedals [11, fig. 4-1] forces are simulated by spring-loaded bungees in the control system. The bungees apply loads to the pilot controls in proportion to stick or pedal movement, but the resultant feel has no relation to actual air loads.

A nonlinear stick-to-stabilizer displacement ratio is incorporated in the pitch control linkage to minimize sensitivity. Pitch trim is obtained by shifting the neutral "no-load" position of the feel bungee to a stick position corresponding to the desired horizontal stabilizer position.

Roll and yaw trim is adjustable only on the ground to compensate for airplane asymmetrical conditions.

Horizontal Stabilizer (Roll-Pitch Control)

The horizontal stabilizer [1, fig. 3-1] consists of two all-movable, one-piece surfaces which can be moved simultaneously, differentially, or in compound.

Aerodynamic control in pitch is obtained by simultaneous displacement of the left and right stabilizer surfaces. Roll control is obtained by differential displacement of the stabilizer surfaces. Combined pitch-roll control is obtained by compound movement of the stabilizer surfaces.

A series of mixer bell cranks sum pilot control and SAS inputs to the two stabilizer actuator valves to obtain the desired pitch or roll-pitch control surface displacement.

Vertical Stabilizers (Yaw Control)

Aerodynamic control in yaw mode is obtained through displacement of the upper [4, fig. 3-1] and ventral vertical stabilizers [17, fig. 3-2], which are actuated simultaneously through the coupled linkage between the upper and ventral vertical stabilizer actuator valves. Pilot pedal [11, fig. 4-1] displacement and SAS yaw inputs are transmitted by mechanical linkage and cables to the synchro-

nized upper and ventral stabilizer control valves.

Since the ventral extends below the main landing skids, it must be jettisoned before landing. Four explosive bolts and a piston containing an explosive charge are electrically fired when the ventral jettison button [67, fig. 5-1] is depressed. If this is not done, or if the ventral fails to jettison when the button is depressed, the ventral will jettison automatically when the landing gear is lowered. For either method of jettisoning, however, the ventral arming switch [35, fig. 5-1] must be at **ARM**, to arm the jettison circuits.

Note: In the simulation, the ventral is "invisible" when the aircraft sits on the ground. It appears when the aircraft is airborne (if not jettisoned).

AERODYNAMIC FLIGHT CONTROLS AND INDICATORS

Center stick

The center stick [8, fig. 4-1] is designed for use during normal periods of longitudinal and vertical acceleration. Pilot pitch and roll inputs to the center stick are summed by the mixer bell cranks and applied to the horizontal stabilizer actuator valves. A microphone button and alternate trim switch are on the stick grip. The button is in parallel with the microphone button on the console stick [3, fig. 5-5].

Clicking the stick handle in the virtual cockpit disables the ballistic control stick [8, fig. 5-4] and enables the center stick and the right console stick [3, fig. 5-5]. The center stick is enabled by default.

Clicking the microphone button will open the ATC window in the simulator.

The center stick can be made invisible by clicking the center stick boot [9, fig. 4-1]. This gives the pilot a better view of the center pedestal, making the switches and controls more accessible. Click again to show the center stick.

Console Stick

The console stick [3, fig. 5-5], on the right console, enables the pilot to control the airplane throughout the periods of high longitudinal and vertical accelerations. This stick has full range of surface control in pitch and roll and is coupled to the center stick linkage through separate pitch and roll hydraulic boost actuators to reduce console stick pilot control forces and to synchronize displacement of the center and console sticks.

The console stick has a pitch trim knob and a microphone button. The trim knob is graduated in degrees. When the trim control switch [1, fig. 5-4] is in **NORMAL**, moving the trim knob causes corresponding movement of the pitch trim actuator. A microphone button on the console stick is in parallel with the microphone button on the center stick [8, fig. 4-1].

The console stick movements are synchronized with the center stick. Clicking the console stick handle disables the ballistic control stick [8, fig. 5-4] and enables the console stick and the center stick. The console stick is enabled by default.

Clicking the microphone button will open the ATC window in the simulator.

Rudder Pedals

Conventional rudder pedals [11, fig. 4-1], which are adjustable, are mechanically linked to the yaw system mixer bell crank. Pedal

movement and SAS inputs are summed by a mixer bell crank, which in turn transmits the summed signal mechanically to the stabilizer actuator control valves.

Trim Control Switch

This two-position switch [1, fig. 5-4], on the left side of the cockpit, controls selection of normal or alternate trim.

With the switch at the maintained **NORMAL** position, the center stick [8, fig. 4-1] trim control knob is inoperative and primary AC and DC power is applied to the electronic trim amplifier and relay unit to activate the console stick pitch trim knob [4, fig. 5-5]. Movement of the pitch trim knob on the console stick then causes primary DC power to be applied to the pitch trim actuator.

With the trim control switch at the maintained **ALTERNATE** position, output of the electronic trim amplifier is cut off, the pitch trim knob is inoperative, and pitch trim is accomplished through the alternate trim switch on the center control stick.

Alternate Trim Switch

This three-position switch (top hat) on the center stick [8, fig. 4-1] controls primary DC bus power to the pitch trim actuator. The switch is spring-loaded to the center position, and all positions are unmarked.

With the switch in the center position and the trim control switch [1, fig. 5-4] at **NORMAL**, primary DC bus power is applied to the electronic trim amplifier and relays, and pitch trim is accomplished by movement of the console stick pitch trim knob [4, fig. 5-5]. Moving the alternate trim switch forward (**NOSE DOWN**) or aft (**NOSE UP**) bypasses the electronic trim amplifier and applied primary DC bus power directly to the pitch trim actuator, causing the actuator to move for nose down or nose up trim, as selected.

If the trim control switch is moved from **ALTERNATE** to **NORMAL**, the pitch trim actuator will run to the preset position of the console stick pitch trim knob.

Ventral Arming Switch

This guarded, two-position switch [35, fig. 5-1] is on the instrument panel right hand wing and is labeled "VENTRAL JETT".

With the switch at **DE-ARM**, the circuit which controls primary DC bus power to the explosive bolts and explosive charge in the ventral [17, fig. 3-2] (or dummy ramjet [18, fig. 3-2]) jettison piston is interrupted and the ventral (or ramjet) cannot be jettisoned either selectively through the ventral jettison button [67, fig. 5-1] or automatically when the landing gear is lowered. With the switch at **ARM**, the ventral (or ramjet) jettison circuit is armed.

Ventral Jettison Button

This jettison button [67, fig. 5-1], labeled "VENTRAL JETT", is recessed within a circular guard on the instrument panel left wing. The button is powered by the primary DC bus and is the primary means of jettisoning the ventral [17, fig. 3-2] (or dummy ramjet [18, fig. 3-2]).
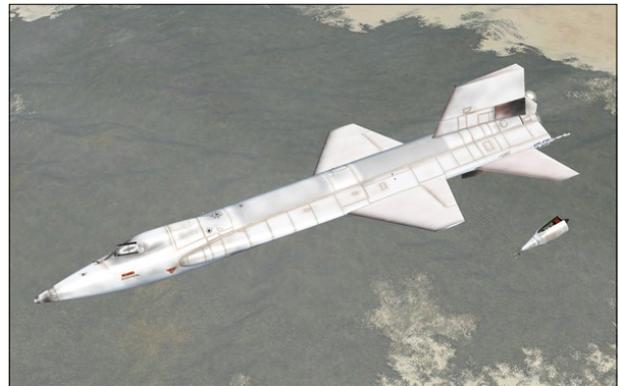
When the button is depressed, with the ventral arming switch [35, fig. 5-1] at **ARM**, four explosive-type bolts and a piston containing an explosive cartridge are fired. At the instant the bolts separate, the piston is driven downward to forcibly jettison the ventral (or ramjet).

Hydraulic Pressure Gage

Refer to "Hydraulic Power Supply Systems".

STABILITY AUGMENTATION SYSTEM (SAS)

While there is no X-15-type stability augmentation system available in Microsoft® Flight Simulator X or Lockheed Martin® Prepar3D®, we thought it would be a good idea to provide our users with the basic autopilot modes offered in the simulator instead. The X-15A-2 SE addon contains a modified SAS panel [48, fig. 5-1] with the basic autopilot controls for altitude hold, wing leveling, attitude hold and yaw damping modes. These controls are described in the "Stability Augmentation System Controls and Indicators" section.

Known Issue

- We noticed that some of the simulator's basic autopilot functions such as "wing leveler" and "altitude hold", when engaged, induce unwanted oscillations at very high speed and altitude (instead of helping the pilot). Unfortunately, we have no other solution at this time but to recommend disengaging these functions when such behavior is encountered until a fix is found. Note that this is no longer an issue in Prepar3D® v4.

SAS Description

On a real mission, at a Mach number of about 3.0 and an angle-of-attack greater than 10°, the X-15 was uncontrollable without damping when normal piloting techniques were used. The stability augmentation system (SAS) [48, fig. 5-1], installed in the real aircraft, provides damping inputs to the aero-dynamic flight control system about the pitch, roll, and yaw axes. Major components of the system are a three-axis gyro, an electronic case assembly, two pitch-roll servo cylinders, one yaw servo cylinder, and a gain selector switch assembly. In-flight testing of the SAS channels can be done by use of an in-flight test unit controlled from the cockpit [7, fig. 5-2].

The SAS has fundamentally three semi-independent channels, each comprising a working circuit, a monitor circuit, and a malfunction detector. Each working circuit received its commands from the gyro assembly in its particular axis and in turn commands associated servo cylinder displacement. The monitor circuits receive commands from the gyro assembly identical to those of the control circuits. The malfunction detectors compare the commands passing through the monitor circuits with the associated servo cylinder displacement. If a predetermined error between the working and monitor circuits is exceeded, the malfunction detector locks out the particular channel in which the error occurred. The working circuit command to the associated servo cylinders is an electrical signal which drives an electro-hydraulic transfer valve on the servo cylinder. The transfer valve controls hydraulic pressure on each side of the servo cylinder piston.

The pitch-roll servo cylinders, powered by the No. 2 hydraulic system, are mechanically linked to the horizontal stabilizer [1, fig. 3-1] control linkage by mixer bell cranks and move surfaces by simultaneous movement of the bell cranks. Roll is achieved by differential movement of the bell cranks. In addition, loss of No. 2 hydraulic system pressure will automatically engage the SAS emergency hydraulic system. Should an abrupt loss of No. 2 system pressure occur, the pitch and roll damping channels may trip. If this occurs, they must be reset.

The yaw servo cylinder, powered by the No. 1 hydraulic system, is mechanically linked to the vertical stabilizer [4, fig. 3-1] control linkage through a mixer bell crank and moves surfaces by movement of the bell crank.

An interaction of the yaw and toll damping working circuits is provided whereby signals

from the yaw axis of the gyro are fed into the roll circuit to augment roll damping. This is referred to as the "yar" function.

The SAS (and the addon's basic autopilot) is powered from the No. 2 primary AC bus and the primary DC bus.

Important

- The avionics must be turned on for the autopilot to engage. To turn on the avionics, turn the radio on by moving the radio function selector switch [1, fig. 5-8] to the right. If the radio function selector switch is set to **OFF**, the avionics is turned off and the autopilot is disengaged. Refer to "Radio Communication and ADF Controls" for more details.

- The SAS circuit breakers [4, 7 and 8, fig. 5-9] must be closed (pushed in) before the airplane is fueled, and must be kept closed until the end of the flight, so that the SAS gyro heaters will be energized to prevent freezing damage to the gyro.

STABILITY AUGMENTATION SYSTEM CONTROLS AND INDICATORS

True X-15-type SAS operation is not supported on the current simulation platforms. However, the X-15A-2 SE addon contains a modified SAS panel [48, fig. 5-1] with the basic autopilot controls for altitude hold, wing leveling, attitude hold and yaw damping modes.

Known Issue

- We noticed that some of the simulator's basic autopilot functions such as "wing leveler" and "altitude hold", when engaged, induce unwanted oscillations at very high speed and altitude (instead of helping the pilot). Unfortunately, we have no other solution at this time but to recommend disengaging these functions when such behavior is encountered until a fix is found. This is no longer an issue in Prepar3D® v4.

SAS Power Switch (Basic Autopilot Switch)

This (fictitious) two-position switch [78, fig. 5-1], on the instrument panel left wing, engages the basic autopilot when positioned to **SAS ON**. To disengage the autopilot, the switch must be returned to **OFF**. The switch is powered by the primary DC bus.

Important

- The avionics must be turned on for the autopilot to engage. To turn on the avionics, turn the radio on by moving the radio function selector switch [1, fig. 5-8] to the right. If the radio function selector switch is set to **OFF**, the avionics is turned off and the autopilot is disengaged. Refer to "Radio Communication and ADF Controls" for more details.

- The SAS circuit breakers [4, 7 and 8, fig. 5-9] must be closed (pushed in) before the airplane is fueled, and must be kept closed until the end of the flight, so that the SAS gyro heaters will be energized to prevent freezing damage to the gyro.

SAS Pitch Function Switch (Altitude Hold Switch)

This three-position switch [5, fig. 5-2], labeled "PITCH", controls the SAS pitch channel circuitry. All switch positions are maintained. The switch is powered by the primary DC bus.

With the switch at **STD BY**, the pitch channel is functioning, but the input signals to the servo cylinder control valves and hydraulic pressure to the servo cylinders are shut off. With the switch at **LO GAIN** or **HI GAIN**, pitch damping signals are applied to the pitch-roll servo cylinder control valves, which in turn permits hydraulic power to be applied to the servo cylinders. If both the pitch and roll function switches are at **STD BY**, the pitch-roll servo cylinders are centered and locked.

Basic autopilot: In the X-15A-2 SE addon, this switch engages the "ALTITUDE HOLD" autopilot mode when set to **LO GAIN** or **HI GAIN**. The "ALTITUDE HOLD" mode is disengaged when the switch is at **STD BY**.

SAS Roll Function Switch (Wing Leveler Switch)

This three-position switch [6, fig. 5-2], labeled "ROLL", is powered by the primary DC bus. It controls the SAS roll channel circuitry. All switch positions are maintained.

With the switch at **STD BY**, the roll channel is operating, but the input signals to the servo cylinder control valves and hydraulic pressure to the servo cylinders are shut off. With the switch at **LO GAIN** or **HI GAIN**, roll damping signals are applied to the pitch-roll servo cylinder control valves, which in turn permits hydraulic power to be applied to the servo cylinders. If both the pitch and roll function switches are at **STD BY**, the pitch-roll servo cylinders are centered and locked.

Basic autopilot: In the X-15A-2 SE addon, this switch engages the "WING LEVELER" autopilot mode when set to **LO GAIN** or **HI GAIN**. The "WING LEVELER" mode is disengaged when the switch is at **STD BY**.

SAS Yaw Function Switch (Yaw Damper Switch)

The yaw function switch [9, fig. 5-2], labeled "YAW", has three maintained positions. The switch is powered by the primary DC bus.

With the switch at **STD BY**, the SAS yaw channel is operating, but the input signals to the

servo cylinder control valve and hydraulic pressure to the servo cylinder are shut off and the yaw servo cylinder is centered and locked. With the switch at **LO GAIN** or **HI GAIN**, yaw damping signals are applied to the yaw servo cylinder control valve, which in turn permits hydraulic power to be applied to the servo cylinder. Shutoff or failure of hydraulic system No. 1 automatically causes the yaw servo cylinder to recenter and lock.

Basic autopilot: In the X-15A-2 SE addon, this switch engages the "YAW DAMPER" autopilot mode when set to **LO GAIN** or **HI GAIN**. The "YAW DAMPER" mode is disengaged when the switch is at **STD BY**.

SAS Yar Function Switch (Attitude Hold Switch)

This two-position switch [8, fig. 5-2], labeled "YAR", is powered by the primary DC bus. Both switch positions are maintained.

The switch controls the yaw signal input to the SAS roll control circuit. With the switch at **STD BY**, the "yar" signal circuit is inoperative. With the switch at **ON** while the roll function switch is at **LO GAIN** or **HI GAIN**, yaw signals are applied to the SAS roll control circuit. If the roll function switch is at **STD BY** or the roll control circuit does not function properly, yaw input to the SAS roll control circuit will neutralize roll and result in a "no roll" output.

Basic autopilot: In the X-15A-2 SE addon, this switch engages the "ATTITUDE HOLD" autopilot mode when set to **LO GAIN** or **HI GAIN**. The "ATTITUDE HOLD" mode is disengaged when the switch is at **STD BY**.

SAS Caution Lights

Four placard-type amber caution lights [1-4, fig. 5-2] indicate operating status of the SAS control circuits (and basic autopilot modes). The lights are powered by the primary DC bus and can be tested through the indicator, caution, and warning light test circuit.

There is one light for each of the pitch, roll, yaw, and "yar" channels. When the lights are

ON, they read "PITCH", "ROLL", "YAW", and "YAR", respectively. The pitch, roll, and yaw lights are on when the pitch, roll, and yaw function switches (see above) are at **STD BY** (or the SAS power switch [78, fig. 5-1] is at **OFF**). When any one of these switches is at **LO GAIN** or **HI GAIN** and its control circuit is operating normally with the SAS power switch at **ON**, the associated caution light is out.

The "YAR" caution light shows only the "yar" function switch position. When the switch is at **STD BY**, the light is on. When the switch is at **ON** and the "yar" signal is available to the roll channels, the light is out.

Note: The SAS caution lights indicate the operating status of the basic autopilot functions of the X-15A-2 SE addon. When a light is on, the function is off. When the function is on, the light is out.

SAS Test Switch

The three-position SAS test switch [7, fig. 5-2] is powered by the primary DC bus. It has momentary WORK and MON positions and a spring-loaded OFF position. While the pitch, roll, and yaw damping channels are engaged, singly or in combination, their working and monitor circuits can be tested during captive or free flight. Placing the switch at either **WORK** or **MON** opens the associated rate gyro ground circuits (working or monitor) and inserts a calibrated test voltage in series with the pick-offs. This voltage is added to the normal output of the gyro and unbalances the SAS channels beyond the expected trip level of the SAS malfunction detectors. If the SAS is functioning properly, the SAS caution lights for the channels being tested will blink, signaling malfunction circuit operation. After each set of circuits (working or monitoring) is tested, the SAS channels must be re-engaged.

Note: The SAS "yar" function switch [8, fig. 5-2] must be at **STD BY** and the SAS power switch [78, fig. 5-1] must be at **SAS ON** during the tests.

SAS (Land) Disengage Switch

This two-position switch [77, fig. 5-1] on the instrument panel left wing, labeled "SAS DIS-ENGAGE," is used to arm the SAS main gear cutout relay to shut off the SAS upon main gear touchdown. When the switch is moved to **ARM**, primary DC bus power is applied to the cutout relay to arm it. Moving the switch to the unmarked off position turns off power to the relay.

ALTERNATE STABILITY AUGMENTATION SYSTEM (ASAS)

Note: The alternate stability augmentation system is not supported in this software version.

On the real aircraft, the alternate stability augmentation system (ASAS) [10-11, fig. 5-2] provides damping inputs to the aerodynamic flight control system about the pitch and roll axes in case of failure of the roll axis of the SAS. Major components of the system are the pitch and roll gyros, electronic case assembly, left and right transfer relays, and left and right serve position transducers, in addition to the servo cylinders and bell cranks which are common to both the SAS and the ASAS.

When the ASAS is armed, failure of the roll channel in the SAS will automatically energize the ASAS. Change-over to the ASAS does not affect the yaw channel of the SAS, which continues to function in the normal manner. The ASAS is completely separate from the SAS and comprises a working circuit only, bypassing all SAS controls and indicators which are then inoperative (except for those in the yaw channel). To completely bypass the SAS electrical circuitry, a servo position transducer, separate from those on the SAS servo cylinders is on the left and right SAS bell cranks to transmit servo cylinder position feedback to the ASAS gyros and electronic case assembly. The ASAS is powered from the No. 2 primary AC bus and the primary DC bus.

ALTERNATE STABILITY AUGMENTATION SYSTEM CONTROLS AND INDICATORS

Note: The alternate stability augmentation system is not supported in this software version. Consequently, the ASAS switch and light do not perform any simulator function, other than being animated to simulate ASAS-related procedures.

The ASAS switch and indicator light are on the SAS/ASAS/RAS panel [48, fig. 5-1], on the main instrument panel.

Alternate SAS Switch

This two-position switch [11, fig. 5-2], labeled "ALT SAS", permits automatic changeover to the ASAS at pilot option. When the switch is at **OFF**, the system has power applied and is in a stand-by condition. When the switch is moved to the **ON** position, a malfunction in the roll channel of the SAS, or placing of the SAS roll function switch [6, fig. 5-2] at **STD BY**, will cause the transfer relay to be energized, thereby connecting the ASAS input signals to the pitch-roll serve cylinders and disconnecting the SAS input signals. The switch is powered by the primary DC bus.

Alternate SAS-On Light

A placard-type green indicator light [10, fig. 5-2], labeled "ALT SAS ON", informs the pilot

when the ASAS is engaged and operating. The light is powered by the primary DC bus and can be tested through the indicator, caution, and warning light test circuit.

BALLISTIC CONTROL SYSTEM

About Ballistic Control on your Simulation Platform

At the time of publication, ballistic control for rocket airplanes was still not supported in either Microsoft® Flight Simulator X or Lockheed Martin® Prepar3D®.

Because aerodynamic control surfaces become less and less effective above about 125,000 feet in the simulator as dynamic pressure decreases, we recommend flying the X-15A-2 addon below 200,000 feet. The simulator will still give you limited control at high altitudes, but flying will become more challenging.

Note: The highest altitude attained by the real X-15A-2 rocket plane was 249,000 feet (August 3, 1966).

We found that the best way to complete a ballistic trajectory at high altitude is to level off and maintain heading after the engine is cut off. With the nose slightly down, eventually the aircraft will lose altitude until the control surfaces become effective again. For more information about this technique, refer to "The X-15 Experience".

Slew Commands for Repositioning the Aircraft without Flying in Real Time

It is also possible to "control" the aircraft in pitch, roll and heading (bank) at higher altitudes by using the slew commands in the simulator.

Slew mode can be toggled with the "**Y**" key. You can use your joystick to move the aircraft on its axis. For more precise movements, we recommend using the keyboard:

Slew Mode (on/off)	Y
Freeze All Movement	Num Pad 5
Slew Forward	Num Pad 8
Slew Backward	Num Pad 2
Slew Left	Num Pad 4
Slew Right	Num Pad 6
Slew Up Slowly	Q or F3
Slew Up Quickly	F4
Slew Down Slowly	A
Slew Down Quickly	F1
Rotate Left	Num Pad 1
Rotate Right	Num Pad 3
Pitch Nose Up	9
Pitch Nose Up Quickly	F5
Pitch Nose Down	F7
Pitch Nose Down Quickly	F8
Freeze Pitch	F6
Bank Left	Num Pad 7
Bank Right	Num Pad 9
Heading North/ Attitude Level	CTRL+SPACEBAR

Ballistic Control System Description

On the real aircraft, the ballistic control system is used to control airplane attitude at flight altitudes where aerodynamic flight controls are ineffective.

Ballistic control is provided by two independent systems which normally are operated simultaneously. Each system uses a monopropellant which is converted by catalytic action to superheated steam and oxygen and is released through small rockets in the nose section and wings. The reaction of the escaping gas causes the airplane to move about the selected axis or combination of axes.

The monopropellant, hydrogen peroxide (H_2O_2), is supplied from the APU and ballistic control propellant feed systems.

The hydrogen peroxide tank which supplies the No. 1 APU also supplies the No. 1 system of the ballistic controls. The tank which supplies the No. 2 APU also supplies the No. 2 system of the ballistic controls.

Movement of the ballistic control stick [8, fig. 5-4] in the cockpit opens a metering valve, allowing the monopropellant to enter the selected rockets. In the rockets, the hydrogen peroxide enters catalyst chambers, where it is decomposed into a high-pressure gas mixture of superheated steam and oxygen. The gases then exhaust through the nozzles. The reaction of the escaping gases causes the airplane to move about the selected axis in a direction opposite to that of the escaping gases.
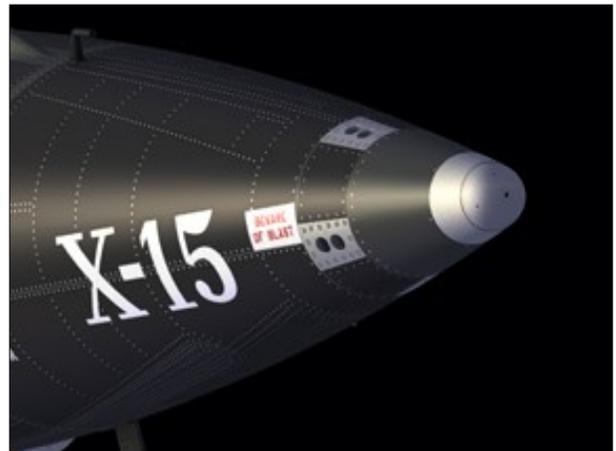
There are six rockets in each system. One system includes four rockets in the nose and the two left wing rockets. The other system includes the remaining four rockets in the nose and the two right wing rockets. A dual metering valve controls flow of the monopropellant to the eight nose rockets for pitch and yaw, and a dual metering valve controls flow of the monopropellant to the four wing rockets for roll.

Flow of the monopropellant to the metering valves is controlled by two switches in the cockpit, one for each system. With both systems operating, a nose-down selection from the cockpit causes operation of the two rockets in the top of the nose section. A nose-right selection from the cockpit causes operation of the two rockets in the left side of the nose. A right-roll selection from the cockpit causes operation of the rocket whose nozzle is in the bottom of the left wing and the rocket whose nozzle is in the top of the right wing.

Stick force gradients are maintained for all three axes of operation by spring bungees. For the pitch and yaw axes, an increase in force versus deflection rate of the ballistic control stick marks half of the maximum control travel and half of the maximum force. Thus, the pilot feels the mid-point of maximum opening of the metering valve. The acceleration and velocity of airplane movement about an axis vary with the amount and duration of ballistic control stick application. The velocity tends to sustain itself after the stick is returned to the neutral position. A subsequent stick movement opposite to the initial one is required to cancel the original attitude change.

The No. 1 ballistic control system rockets also are used by the reaction augmentation system (RAS).

If either ballistic control system fails, the other system provides adequate power to control the airplane. A transitional altitude band exists wherein it will be necessary to use the ballistic control system and the aerodynamic flight controls simultaneously for maneuvering and controlling airplane attitude. The size of this transitional band is somewhat affected by airplane speed and the amount of maneuvering or attitude change required.

BALLISTIC CONTROL SYSTEM CONTROLS

At the time of publication, ballistic control for rocket airplanes was still not supported in either Microsoft® Flight Simulator X or Lockheed Martin® Prepar3D®. Consequently, the BCS and RAS controls and switches in the X-15A-2 SE do not perform any simulator function in this software version, other than being animated to simulate BCS and RAS-related procedures. The ballistic control stick [8, fig. 5-4] in the virtual cockpit follows the movement of the center stick [8, fig. 4-1] to simulate BCS operation at high altitude.

Ballistic Control Switches

The No. 1 and No. 2 ballistic control switches [18 and 27, fig. 5-1], on the instrument panel, are powered by the primary DC bus.

Moving either switch to **ON** simultaneously opens the helium shutoff valve and the propellant feed system jettison and ballistic control valve for the respective system and allows hydrogen peroxide to flow to the metering valves. With either switch at **OFF**, the propellant feed system jettison and ballistic control valve for the respective system is turned off. However, the helium shutoff valve will not close as long as either APU switch [17 or 30, fig. 5-1] is at **ON**.

Note: When either APU switch is at **JETT**, the feed system jettison and ballistic control valve for the related system of the ballistic controls closes and shuts down that system.

Ballistic Control Stick

The ballistic control stick [8, fig. 5-4], above the left console, is mechanically connected to the system metering valves. When the ballistic control system is operating, moving the stick positions the metering valves to allow flow of hydrogen peroxide to the selected rockets in the nose and wings.

Yaw control is obtained by direct left or right movement of the stick. For left yaw, the stick must be moved directly to the left.

Roll control is obtained by rotation of the stick. For left roll, the stick must be rotated to the left (counterclockwise).

Pitch control is obtained by direct up or down movement of the stick. An airplane nose-up pitch change is obtained by raising the stick.

Note: Clicking the ballistic control stick handle in the virtual cockpit disables the center stick [8, fig. 4-1] and the right console stick [3, fig. 5-5] and enables the ballistic control stick. The ballistic control stick is disabled by default.

Nose Ballistic Rocket Heater Switch

The nose ballistic rocket heater switch [34, figure 5-1], on the instrument panel right-hand wing, receives electrical power from the carrier airplane. Moving this switch to **ON** during captive flight starts the electric heaters on the ballistic control system rockets in the nose of the X-15 to preheat the rockets. After launch, this switch is inoperative.

REACTION AUGMENTATION SYSTEM (RAS)

The reaction augmentation system is not supported in this software version (see "Ballistic Control System").

On the real aircraft, the reaction augmentation system (RAS) provides rate damping to aid airplane control and minimize pilot over-control when the ballistic control system is used. The RAS conserves APU and BCS H_2O_2 supply by minimizing pilot over-control

tendencies at low acceleration levels.

The RAS is incorporated in the No. 1 ballistic control system and uses the rocket motors associated with that system. Pilot control of both system No. 1 and No. 2 rocket motors is still maintained.

Whenever the ballistic control stick [8, fig. 5-4] is in neutral, the RAS gyro accelerometer assembly senses angular rate about the three axes and at a preset angular rate, a switching system is energized to fire the proper No. 1 system rocket motor to reduce the sensed angular acceleration. The RAS is automatically turned off by means of an acceleration-sensing device upon a build-up of G, which corresponds to an increase in the effectiveness of the aerodynamic controls.

The RAS can be overridden by the pilot in case of a failure.

The RAS is in a stand-by condition whenever power is applied to the airplane and is engaged by switches in the cockpit. Any combination of the three axes can be selected individually as desired. An indicator light in the cockpit shows when the RAS is in stand-by.

Electrical power for the RAS is obtained from the No. 1 primary AC bus and primary DC bus. The system is protected by circuit breakers in the equipment bay.

REACTION CONTROL SYSTEM CONTROLS AND INDICATORS

The reaction augmentation system is not supported in this software version (see "Ballistic Control System"). Consequently, the RAS switches and lights do not perform any simulator function, other than being animated to simulate RAS-related procedures.

Reaction augmentation system switches and lights are on the SAS/ASAS/RAS control panel [48, fig. 5-1], on the main panel, and on the left white control box [15, fig. 4-1], above the ballistic control stick [8, fig. 5-4].

RAS Accelerometer Switch

The two-position accelerometer switch [16, fig. 5-2] on the SAS/ASAS/RAS control panel [48, fig. 5-1] is labeled "AUTO CUT OFF". Moving the switch to **ON** engages the automatic cutoff. The automatic cutoff of the RAS will occur when a preset level of normal acceleration is sensed. When automatic cutoff occurs, an indicator light [12, fig. 5-2] comes on. To reset the automatic cutoff feature, the switch is moved to **OFF**, then returned to **ON**. The OFF position disengages only the automatic cutoff feature, not the RAS. The switch is powered by the primary DC bus.

RAS Pitch Switch

The two-position pitch switch [13, fig. 5-2] on the SAS/ASAS/RAS control panel [48, fig. 5-1] has ON and OFF positions. Moving the switch to **ON** closes the pitch circuit and permits operation of the proper pitch rocket motor by the RAS. With the switch at **OFF**, the pitch output circuit is opened. The switch is powered by the primary DC bus.

RAS Roll-Switch

The two-position roll switch [14, fig. 5-2] on the SAS/ASAS/RAS control panel [48, fig. 5-1] has ON and OFF positions. Moving the switch to **ON** closes the roll circuit and permits the operation of the proper roll rocket motor by the RAS. With the switch at **OFF**, the roll output circuit is opened. The switch is powered by the primary DC bus.

RAS Yaw Switch

The two-position yaw switch [15, fig. 5-2] on the SAS/ASAS/RAS control panel [48, fig. 5-1] has ON and OFF positions. Moving the switch to **ON** closes the yaw circuit and permits operation of the proper yaw rocket motor by the RAS. With the switch at **OFF**, the yaw output circuit is opened. The switch is powered by the primary DC bus.

RAS-Out Indicator Light

The RAS-out indicator light [12, fig. 5-2] on the SAS/ASAS/RAS control panel [48, fig. 5-1], receives primary DC bus from the gyro accelerometer assembly and comes on to show "RAS OUT" whenever automatic cutoff occurs or if the control switches of all three axes are at **OFF**.

Moving any one of the three switches to **ON** turns off the light if the automatic cutoff circuit has not been tripped. If the light is on because of automatic cutoff, the automatic cutoff circuitry can be reset by moving the accelerometer switch [16, fig. 5-2] to **OFF**, then to **ON**, to put out the light. The light can be tested through the indicator, caution, and warning light test circuit.

RAS Indicator Lights

Three amber indicator lights [10, fig. 5-4], labeled "YAW", "ROLL", and "PITCH", on the left white control box [15, fig. 4-1], are powered by the primary DC bus and come on whenever the corresponding yaw, roll, and pitch RAS switch [13-15, fig. 5-2] is in the **ON** position. The lights can be tested through the indicator, caution, and warning light test circuit.

WING FLAPS SYSTEM

The 25½ degree swept back wing [2, fig. 3-1] has hydraulically operated flaps [12, fig. 3-2] on the inboard trailing edge of each wing panel. Flap position is controlled by an electromechanical actuator, containing two electric motors that are coupled together by a set of differential gears. The output of this actuator drives a push-pull cable system which opens the valves in the dual, tandem hydraulic flap actuators and hydraulically positions the flaps to either full up or full down.

Flap extension is possible even if one motor fails; however, the extension time is approximately twice the normal time. Normal extension from full up to full down position requires about 8 to 10 seconds.

No provisions have been made for automatic pitch correction with flap extension, nor for intermediate positioning of the flaps. However, because of the incorporation of hydraulic relief valves to limit the maximum air load on the surfaces, the flaps may partially close at speeds above 250 knots. No flap position indicator is provided.

Wing Flap Switch

A two-position switch [9, fig. 5-4] is on the left white control box [15, fig. 4-1], above the ballistic control stick [8, fig. 5-4]. The switch, labeled "FLAP", controls flap operation, and is powered by the primary DC bus.

It has two positions, UP and DOWN. No intermediate positioning is provided.

Note: There are no flaps on the fictitious delta wing X-15AD-4.

SPEED BRAKE SYSTEM

The airplane has two split-flap speed brakes [3 and 34, fig. 3-1], one on the fixed portion of the upper vertical stabilizer and the other on the fixed lower vertical stabilizer.

Each speed brake consists of two symmetrical panels, hinged at the forward end. Each speed brake is operated by a dual, tandem hydraulic actuator. One segment of an actuator is powered from hydraulic system No. 1; the other segment, by hydraulic system No. 2.

Failure of one hydraulic system still permits operation of the speed brakes, however, at reduced rate under any particular air load.

Known Issue (FSX, Prepar3D® v1)

- Due to some limitations in FSX and Prepar3D® v1, it is possible to observe the movement of the control surfaces, including the speed brakes, without the APUs operating and providing hydraulic power to the motors. Of course, this was not possible on the real aircraft. Fortu-

nately, this is no longer an issue in Prepar3D® v2 and later.

The actuator valves are controlled from the cockpit by a system of cables and mechanical linkage. Follow-up mechanisms permit positioning each speed brake to any position between fully closed and fully open.
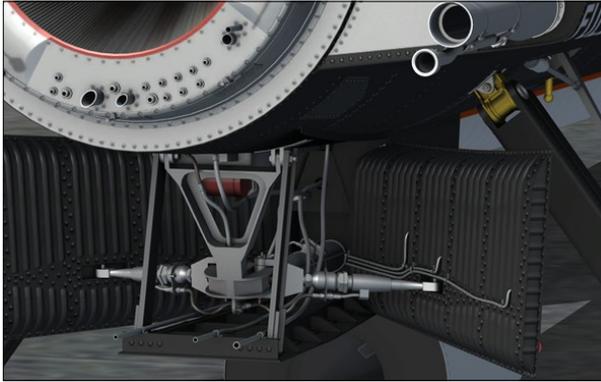
Note: Each speed brake actuator incorporates a relief valve which prevents the speed brake from extending or allows the speed brake to retract under excessive air loads, to prevent structural damage.

Warning

- The speed brakes on this airplane we re not designed for use as a low-speed drag device; opening them at subsonic speeds can be dangerous. Their design function is to provide necessary drag conditions for control of the airplane at supersonic speeds and relatively high altitudes.

Speed Brake Handles

The speed brake handles [13 and 14, fig. 5-4] are on the left console.

The inboard handle controls the lower speed brake; the outboard handle controls the upper speed brake. The handles normally are locked together by an interconnecting bolt at the forward cable sectors to ensure symmetrical operation of the speed brakes. A spring-loaded lock lever on the inboard handle is designed to unlock the handles for independ-

ent speed brake operation and lock them for symmetrical operation if the interconnecting bolt is not installed.

Note: The upper and lower speed brake handles, in the virtual cockpit of the X-15A-2 SE addon, are locked together and can be dragged to the desired position with the mouse.

Speed brake position is indicated by a scale for each handle on the speed brake handle quadrant. The scales are calibrated in increments of 5 degrees. When the handles are moved to a given setting, the speed brakes will open to the position selected.

LAUNCH SYSTEM

The dropping of the real airplane from the carrier airplane is normally performed by the pilot of the carrier airplane. However, if this cannot be done, the captive airplane is equipped with an auxiliary launch switch to perform this function from a separate power source. A switch in the captive airplane controls an indicator light in the carrier airplane to indicate that the pilot of the captive airplane is ready for launch.

Ready-to-Launch Switch

The ready-to-launch switch [52, fig. 5-1], on the main instrument panel, is moved to **ON** to light the "READY TO LAUNCH" indicator light in the carrier airplane when the captive airplane is ready to be dropped. There is no indicator light in the captive airplane. Moving the ready-to-launch switch to **OFF** turns out the indicator light. This circuit is powered by the carrier airplane's electrical system.

Note: Status of the ready-to-launch switch/ light can be monitored on the system monitor panel.

Auxiliary Launch Switch

The guarded, battery-bus-powered auxiliary launch switch [60, fig. 5-1], on the instrument panel left wing, uses primary DC bus power to operate the hydraulic launch system in the carrier airplane. Lifting the guard and moving the switch up (**ON**) supplies power directly to the solenoid valve in the normal launch hydraulic system.

Note: Moving this switch has no effect in the current software version.

LANDING GEAR SYSTEM

The two main landing gears [35, fig. 3-1] are of the skid type and lie adjacent to the lower aft fuselage and parallel to the airplane centerline when retracted. The skids are mounted on inflexible struts with an air-oil shock absorber attached to the upper end which

permits some outward rotation when the weight of the airplane is on the landing gear.

The nose gear [18, fig. 3-1] is a conventional, non-steerable, dual-wheel type and retracts forward, fairing into the fuselage nose section.

Both the main and nose gear, when unlocked, extend by gravity and air loads. However, the

nose gear lowering system includes an initiator to ensure positive nose gear lowering. They cannot be retracted by the pilot. No gear-down indication is provided.

Gear retraction must be accomplished manually by ground personnel. When the main gear is released, a microswitch on the left main gear activates an explosive charge, causing the ventral [17, fig. 3-2] (or dummy ramjet [18, fig. 3-2]) to jettison, provided the ventral arming switch [35, fig. 5-1] is at ARM and if the ventral had not been previously jettisoned by use of the ventral jettison button [67, fig. 5-1].

Note: The nose gear on the X-15A-2 SE addon is steerable. The nose and main landing gear can be extended or retracted by the pilot.

Known Issue

- The landing gear is configured so it (and the aircraft) sits properly on the ground on most hard surfaces such as a concrete runway or a dry lakebed. However, it is normal for the landing gear to be partially buried into the ground or even to "float" above it if you land the aircraft on a rough, soft (sandy) or uneven terrain, for example, after an emergency landing somewhere in the desert. This also depends on the resolution of the mesh on which it sits. This is a terrain issue and not an addon issue.

- The X-15 was not designed for a normal takeoff from the ground. Because of the position of the rear landing gear relative to the center of gravity, it is normal for the rear skids to sink slightly into the ground when the airplane takes off, especially if you pull back too much on the center stick.

Landing Gear Handle

The T-type landing gear handle [65, fig. 5-1] is on the instrument panel left wing.

The handle is mechanically linked to the main gear [35, fig. 3-1] uplocks and the nose gear [18, fig. 3-1] and nose gear door [19,

fig. 3-1] uplocks. When the handle is pulled straight aft approximately 11 inches, the uplocks are released, the spring-loaded scoop door [20, fig. 3-1] in the nose gear door swings downward into the airstream, and the nose gear extension initiator fires. The initiator actuates a piston which forces the nose gear door open under flight attitudes where air loads tend to hold the door closed.

Air loads on the nose gear scoop door force the nose gear down and locked. Gravity and air loads cause the main gear to extend and lock.

The landing gear handle should be manually stowed to prevent possible damage to the instrument panel.

Note: When the yellow landing gear handle is pulled straight aft (dragged with the mouse in the virtual cockpit), both landing gear extend. On the real aircraft, the X-15 landing gear could not be retracted by the pilot. However, dragging the landing gear handle back to its original position in the virtual cockpit will retract the landing gear in the simulation.

Caution

- If the "Ignore crashes and damage" option is not selected on the "Settings – Realism" page in the simulator and the aircraft exceeds a certain speed limit (about 300 KIAS) just after takeoff with the landing gear still extended, the gear will be damaged and will not retract. To avoid this problem, always check the airspeed and retract the landing gear as soon as the X-15 is airborne or select the "Ignore crashes and damage" option.

INSTRUMENTS

Most of the instruments are powered by the AC or DC electrical systems or a combination of both.

PITOT-STATIC SYSTEM

Pitot pressure for the conventional airspeed indicator [5, fig. 5-1] and altimeter [3, fig. 5-1] is supplied by the fuselage-mounted static

"dog-leg" pitot tube [15, fig. 3-1].

A retractable pitot tube [38, fig. 3-1] is installed ahead of the static pitot tube. The retractable pitot tube is provided on the X-15A-2 because the static tube's operating temperature limits would be exceeded at higher Mach numbers. Also, the retractable pitot tube, when retracted, is protected from possible ablator spills. The retractable pitot tube remains within the fuselage until the airplane decelerates to below Mach 2.

Static pressure is supplied by ports on each side of the fuselage, forward of the cockpit area.

The NACA-Nortronics ball nose [17, fig. 3-1] is a sphere-shaped, pitot-pressure, flow-direction sensor. The ball simultaneously measures angle of attack and angle of side-slip through two complete and independent servo systems.

One system controls the vertical and one the horizontal axis. As the airplane encounters a sideslip condition or change in angle of at-tack, the respective system will turn the ball

(electro-hydraulically) into the relative wind. The difference between airplane heading and relative wind is then transmitted through sensors to cockpit instruments to read angle of attack and angle of sideslip.

Electrically, the ball nose is powered through the instrumentation transformer, which in turn is powered by the No. 2 primary AC bus.

Hydraulic power for the ball nose is provided from the No. 1 hydraulic system. If hydraulic system No. 1 fails, the ball nose will not turn in response to sensor signals. In this event, the angle-of-attack and sideslip indicators (on the attitude indicator [9, fig. 5-1]), although inoperative, will provide erroneous indications, as they will continue to register the conditions at the time of the power failure.

In case of electrical failure, the indicators may show a continually unsafe condition.

Known Issue

- Depending on the wind, the ball nose on the X-15A-2 SE addon may move in an exaggerated manner while the aircraft is still sitting on the runway, making the needles on some instruments go crazy. It is normal to see the ball nose moving in the direction of the wind, but not in such manner. This seems to be a minor simulator issue that cannot be resolved at this time. The unwanted effect disappears when the aircraft is airborne. This affects the ball nose and the angle-of-attack and side-slip indicators in the cockpit.

PITOT-STATIC SYSTEM INSTRUMENTS AND CONTROLS

Retractable Pitot Tube Handle

The white T-type landing gear handle [80, figure 5-1] is on the main instrument panel, to the left of the airspeed/Mach indicator.

The handle is mechanically linked to the retractable pitot tube assembly [38, fig. 3-1]. When the handle is pulled straight aft approximately 8 inches, the retractable pitot tube door opens and the pitot tube extends.

When the handle is pushed back to its forward position, the pitot tube retracts and the door closes.

Ball Nose Power Switch

This two-position switch [6, fig. 5-3] is on the center pedestal and is labeled "BALL NOSE." With the switch at **ON**, electrical power is available for excitation of the bail nose servos.

Ball Nose Test Button

This push-button type switch [7, fig. 5-3] on the center pedestal is labeled "BALL NOSE TEST" and is used to test operation of the ball nose in flight.

Depressing and holding the button applies an error signal to the ball nose transducers. This error signal electrically simulates a predetermined airplane sideslip angle and angle of attack, which are presented on the angle-of-attack indicator [7, fig. 5-1] and vertical and horizontal pointers on the attitude indicator [9, fig. 5-1]. When the button is released, the ball nose should drive rapidly to an extreme position, resulting in full-scale deflection of the angle-of-attack indicator pointer and vertical and horizontal pointers on the attitude indicator. This indication should be maintained for about 2 to 3 seconds; then the ball nose should drive rapidly without overshoot to indicate the actual airplane sideslip angle and angle of attack.

Note: Full-scale deflection of the angle-of-attack indicator pointer and vertical and horizontal pointers on the attitude indicator when the button is released and the subsequent return to normal readings, are positive indications of proper operation of the ball nose.

Accelerometer

A three-pointer accelerometer [8, fig. 5-1], on the instrument panel, shows positive and negative G-loads.

One pointer continuously indicates accelera-

tion forces. Two recording pointers indicate maximum positive and negative G encountered. The recording pointers may be reset by clockwise movement (single mouse click) of the reset knob on the lower left corner of the instrument.

Dynamic Pressure Gauge

This single-pointer gauge [10, fig. 5-1], on the instrument panel, shows the dynamic pressure in front of the aircraft.

Clicking the instrument front glass with the mouse will show/hide the optional radio-magnetic indicator that occupies the same space on the center panel.

Altimeter

The altimeter [3, fig. 5-1], on the instrument panel, has standard 1000 and 100-foot pointers and a 10,000-foot pointer extending from a movable center disk to the edge of the dial, so that it cannot be obscured by the other pointers. The center disk also has a wedge-shaped cutout through which a set of warning strips appear at altitudes below 16,000 feet. This altimeter offers improved readability and gives warning when an altitude of less than 16,000 feet is entered.

Airspeed/Mach Indicator

The airspeed/Mach indicator [3, fig. 5-1], on the instrument panel, has an airspeed needle

fixed to a rotating plate with a range of 80 to 850 knots. The needle also indicates Mach number when airspeed is above 250 knots.

The Mach scale rotates under the airspeed pointer plate and is visible through a cutout in the plate at airspeeds above 250 knots. The Mach scale rotates with altitude changes so that the indicating pointer will show the Mach number that equals the indicated airspeed for the particular flight altitude.

The indicator has an adjustable airspeed setting index marker that is moved to the desired position by a knurled knob at the lower right corner of the instrument ring. The index marker can be used for referencing any desired in-flight speed as well as landing speed.

A movable red hand is set by maintenance personnel to indicate 700 knots EAS. As altitude is increased, changes in outside air density cause the hand to move to a higher IAS reading.

Angle-of-attack Indicator

A remote-type angle-of-attack indicator [7, fig. 5-1], on the instrument panel, is electrically driven by power from both the No. 2 primary AC and primary DC busses. The ball nose measures the angle between the relative wind and the fuselage reference line. The attack angle so determined is then transmitted to the indicator. The indicator has a range from 10 degrees nose down to 40 degrees nose up.

Rate-of-Roll Indicator

A rate-of-roll indicator [49, fig. 5-1], on the instrument panel, is electrically powered by the primary DC bus. The rate-of-roll inclicator indicates the roll rate in degrees per second for right and left roll from 0 to 200 degrees per second.

INERTIAL ALL-ATTITUDE FLIGHT DATA SYSTEM (STABLE PLATFORM)

Note: For convenience of presentation, the inertial all-attitude flight data system henceforth is referred to as the **stable platform** system.

The stable platform system is essentially a navigating system designed to function over the earth within a high range area, approximately 720 miles long and 240 miles wide. Primarily, the system provides an attitude, velocity, and height record in a flight environment in which conventional flight reference instruments cease to function (that is, during prolonged operation at high altitudes and Mach numbers).

The equipment in this system is operated with no angular range limitations or tumbling effects inherent in conventional gyro equipment. The system displays primary flight data to the X-15 pilot and transmits this data to recorders in the X-15 airplane.

The system is divided functionally into two groups. The first group, in the X-15, consists of the platform, computer, and flight instruments, which present attitude, velocity, and altitude indications. This equipment supplies all the required data after the X-15 is launched. The platform itself has four independent gimbals that permit unlimited maneuvers about the longitudinal, lateral, and vertical axes. It also has three gyros and three accelerometers.

The second group, in the carrier airplane, is used to supply the proper initial conditions to the computer and thus align and stabilize the platform before launch. A control panel in the carrier airplane enables an operator to continuously monitor performance of the flight data system before launch, and to preset the required calibrations to the X-15 through an umbilical cord. In captive flight, the system is slaved to compass and velocity-measuring equipment in the carrier airplane. During free flight, the system dead-reckons from the launch point.

STABLE PLATFORM CONTROLS AND INDICATORS

Note: In referring to electrical power sources in the following paragraphs, it is considered that the stable platform switch [33, fig. 5-1] is positioned at **INT** and that the system controls and indicators are being powered from the X-15 airplane.

Stable Platform Power Switch

The guarded stable platform power switch [33, fig. 5-1] provides a means for selecting stable platform power, either from the carrier airplane or from the X-15. The switch is on the instrument panel right wing and is labeled "STABLE PLATF PWR". It has three maintained positions: INT, EXT, and OFF.

The OFF position is a détente position. To move the switch from **OFF**, the switch must be pulled out of the détente. Moving the switch to **INT** energizes the platform with No. 2 primary AC bus power from the APU's of the X-15.

Note: Do not turn the stable platform switch to **INT** when the APU's are off.

When the switch is moved to **EXT**, the system is energized by power units in the carrier airplane (external power switch [22, fig. 5-3] at **ON**).

Note: The switch should be moved from **EXT** to **INT** just before launch. However, if this is not done, power will be automatically transferred from the carrier airplane to the X-15 at time of launch.

Turning the switch to **OFF** shuts off all power to the platform system.

The guard must be removed with a single mouse click before the switch can be actuated. The guard cannot be reinstalled once removed unless the flight is reset.

Stable Platform Instrument Switch

This two-position switch [10, fig. 5-3] on the center pedestal is labeled "S/P INSTR". The switch controls power to the stable platform indicators in the cockpit. It is used during ground checks of the stable platform system to interrupt power to the instruments when their operation is not required to perform the check-out. With the switch at **OFF**, power to the stable platform instruments is interrupted. Except during ground checks, the switch must be at **ON**.

Side-Slip Selector Switch

This two-position switch [12, fig. 5-1] is on the main instrument panel and has "DELTA PSI" and "STANDBY" positions. With the switch at **STANDBY**, side-slip signals derived from the ball nose are presented on the attitude indicator's vertical pointer [9, fig. 5-1]. With the switch at **DELTA PSI**, side-slip (or delta track) signals derived from the stable platform are presented on the vertical pointer of the attitude indicator.

Attitude Indicator

The attitude indicator [9, fig. 5-1], on the instrument panel, is powered by the primary DC bus and the No. 2 primary AC bus.

It is a pictorial-type instrument that combines displays of attitude and azimuth on a universally mounted sphere displayed as the background for a miniature reference airplane.

The sphere (remotely controlled by the stable platform) is free to rotate 360 degrees in pitch, roll, and azimuth. The miniature reference airplane is always in proper physical relationship to the simulated earth, horizon, and sky areas of the background sphere.

The horizon on the sphere is represented as a solid white line. On this horizon line is an azimuth scale graduated in 5-degree markings from 0 through 360 degrees. Above the horizon line, the sky is indicated by a light-gray area. Below the horizon line, the earth is indicated by a dull-black area. The sphere is marked by meridian lines spaced every 30 degrees. Fitch angle is referenced to the center dot of the fixed miniature airplane by horizontal marks spaced every 10 degrees on the meridians.

A pitch-adjustment knob on the lower right side of the instrument electrically rotates the sphere to the proper position in relation to the miniature airplane to correct for pitch attitude changes. Clockwise rotation of the knob causes the horizon line to deflect upward from the airplane index. Rotating the knob counterclockwise causes the horizon line to deflect downward. Trim setting is au-

tomatically and gradually canceled as airplane attitude approaches the vertical in climb or dive to ensure a true vertical indication. It returns automatically when level flight is resumed.

Note: You can use the radio-magnetic indicator's synchronizer knob to calibrate the sphere's heading indicator. See "Radio-Magnetic Indicator" below.

Bank angles are read from a semicircular bank scale on the lower quarter of the instrument.

Two long pointers project across the sphere. Movement of these pointers shows airplane displacement with respect to the air in which it is flying (small angles of attack and sideslip). The horizontal long pointer is a vernier indication of the angle-of-attack slip indicator [7, fig. 5-1] on the instrument panel. This horizontal pointer moves upward when the angle of attack is increased and downward when the angle of attack is decreased. The vertical long pointer moves to the right to indicate a left sideslip, and to the left to indicate a right sideslip. The range of either pointer movement is adjustable (on the ground) to operate within ±5 to ±10 degrees.

A short horizontal pointer is on the left side of the instrument. This pitch pointer is a vernier indication for the pitch axis of the sphere and moves in the same direction as the sphere. The pointer indicates displacement in a range of ±5 degrees of that angle selected on a pitch angle set control [16, fig. 5-1].

Immediately after launch, the pilot rotates the airplane to the pitch angle that is preset on the pitch angle set control. Initially, the sphere is used to approximate this angle. As the airplane approaches to within 5 degrees of the preselected pitch angle, the small pitch pointer moves toward the center index (0). The pilot then switches his attention from the sphere to the pointer for fine adjustments. The pointer will remain at the zero position as long as the preset pitch angle is maintained.

A turn-and-slip indicator is on the lower portion of the instrument below the bank angle

scale. The rate-of-turn needle is powered by the 26-volt AC bus and the No. 2 primary AC bus. Immediately after electrical power is applied, an "OFF" flag on the lower left section of the indicator retracts. Failure of either AC or DC power causes the "OFF" flag to reappear.

Pitch-Angle Set Control

A pitch-angle set control [16, fig. 5-1], powered by the primary DC bus and the No. 1 primary AC bus, is on the instrument panel, next to the attitude indicator. The control is used in conjunction with the small pitch pointer on the attitude indicator [9, fig. 5-1]. The angle that is set on this control is the pitch angle the pilot will attain for either the climb or the re-entry phase of a mission.

The instrument consists of four counters and a pitch angle set controller knob and lever. Rotating the knob clockwise sets up the desired pitch angle on three of the counters. The number on the far right counter is preceded by a dot to indicate the reading is in tenths of a degree. Counter range is from 0 to 90 to permit selection of any pitch angle up to 90 degrees. Rotating the knob counterclockwise (right clicking with the mouse) returns the three counters to 0. The lever, adjacent to the knob, can be rotated upward or downward (left clicking with the mouse) to change the sign (negative or positive) of the selected pitch angle. When the lever is moved upward, a minus (-) sign shows on the left counter; downward movement produces a plus (+) sign.

For additional information, refer to "The X-15 Experience".

Radio-Magnetic Indicator

An optional radio-magnetic indicator is provided on the center panel. To show/hide the RMI, click the glass in front of the dynamic pressure gauge [10, fig. 5-1], above the attitude indicator [9, fig. 5-1].

The radio-magnetic indicator incorporates one movable compass card, two direction pointers, and one fixed index card.

Note: The index card can be rotated in the simulator by left or right-clicking the synchronizer knob. The card was fixed in the original X-15.

The compass card displays azimuth reference with respect to the surface of the earth. The compass card is synchronized with the stable platform of the flight data system. A push-to-set synchronizer knob at the lower left side of the indicator permits adjustment of the compass card to read airplane azimuth displacement either from magnetic north or from the high range centerline. The knob may be turned (with the mouse wheel) to accurately synchronize the card with the stable platform during initial operation of the system.

Note: Turning the synchronizer knob will also affect the the sphere in the attitude indicator [9, fig. 5-1].

Note: You can use the magnetic heading information displayed in the top left section of the simulator's main window to synchronize the compass card in the RMI and the sphere in the attitude indicator [9, fig. 5-1] (see "Attitude Indicator" above). Press "**SHIFT-Z**" to show/hide the heading information.

The double-barred pointer is synchronized with the antenna of the automatic radio direction finder (ADF) system. It reads displace-

ment between the airplane centerline and a course to the ADF ground station.

The single-barred pointer is synchronized with the VOR antenna. It reads displacement between the airplane centerline and a course to the VOR ground station.

The radio-magnetic indicator is powered by the primary DC bus and the No. 1 primary AC bus.

For more information, refer to "Radio Communication and ADF/VOR System".

Inertial Height Indicator

The inertial height indicator [15, fig. 5-1], powered by the primary DC bus and the No. 1 primary AC bus, is on the instrument panel. The indicator is coupled to the stable platform system computer to automatically indicate any change in height. The computer, in turn, determines the height from vertical accelerations measured by a vertical accelerometer in the stable platform. Height is measured from an arbitrary reference line. This reference line may be determined in one of several ways - pressure altitude, ground control radar, etc. The inertial height indicator has a long 10,000-foot pointer and a short 100,000-foot pointer. Before launch, the pilot should readjust the height indicator (by turning a knob labeled "SET" on the face of the instrument) to his height in relation to the arbitrary reference line to eliminate possible cumulative errors.

Inertial Speed (Velocity) Indicator

The speed (velocity) indicator [14, fig. 5-1] is a single-pointer instrument coupled to the stable platform system computer to indicate airplane trajectory velocity. The computer determines this trajectory velocity from accelerations measured by accelerometers in the stable platform. The indicator, powered by the primary DC bus and the No. 1 primary AC bus, is on the instrument panel and reads in thousands of feet per second from 0 to 7.

Vertical Velocity Indicator

This single-pointer indicator [19, fig. 5-1], on the instrument panel, displays inertial ascent and descent in hundreds of feet per second from 0 to 12. The vertical velocity indicator, powered by the primary DC bus and the No. 1 primary AC bus, is coupled to the stable platform system computer. The computer determines this vertical velocity from accelerations measured by the vertical velocity accelerometer in the stable platform.

INSTRUMENTATION SYSTEM CONTROLS AND INDICATORS

The instrumentation system records a wide variety of data on the basic airframe and airplane systems. The system is powered from the No. 2 primary AC bus and the primary DC bus. Controls and indicators for the system are on the center pedestal
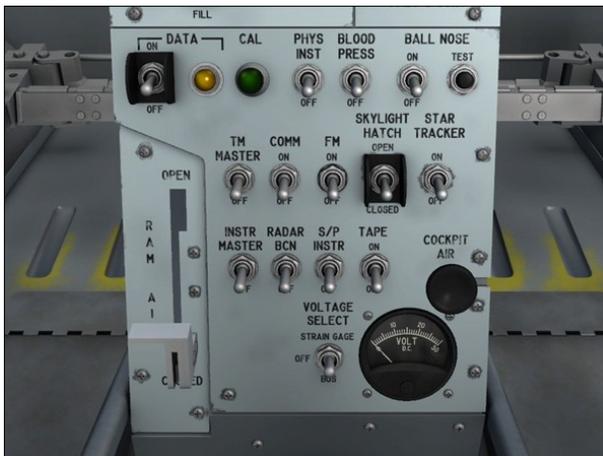
Instrumentation Master Power Switch

Turning this two-position switch [15, fig. 5-3] to **ON** energizes all instrumentation heater circuits, energizes air-borne recording instrumentation DC power circuits, and arms the gyro cage switch, strain gauge power switch, and data switch. Moving the switch to **OFF** electrically de-energizes all instrumentation equipment.

Data Switch and Light

This two-position switch [1, fig. 5-3] energizes all airborne recording media and arms the camera and calibrate switches when it is turned from **OFF** to **ON**. The switch also turns on a neon data light next to the switch. The data light [2, fig. 5-3] blinks in synchronization with the camera timer thus providing a positive indication of correct timer operation and energizing of recorder film magazines.

Data Timer

The data timer [79, fig. 5-1], located under the main panel (next to the panel left wing), shows the remaining recording time (in minutes) on the data tape recorder. Before flight, the timer is set to the maximum recording time by rotating the wheel on the left side of the instrument. A reset button is provided on the right side of the display. With the instrumentation panel energized, the data timer starts counting when both the instrumentation master power switch [15, fig. 5-3] and the tape recorder power switch [9, fig. 5-3] are set to **ON.**

Calibrate Button and Light

This is a spring-loaded, push-button type switch [3, fig. 5-3] with an integral signal light. Momentarily depressing the button triggers the automatic in-flight calibration circuits used with the strain gauge transducers to record the airborne oscillographs. The

signal light in the button comes on green when the button is depressed, to indicate that automatic calibration is in progress. The light continues to glow after the button is released, remaining on until the calibration is completed.

Tape Recorder Power Switch

This two-position switch [9, fig. 5-3], when it is turned from **OFF** to **ON,** energizes the data tape recorder.

Telemeter Master Power Switch

This two-position switch [18, fig. 5-3], when turned from **OFF** to **ON**, energizes all power circuits in the telemeter system.

Telemeter Commutator Motor Switch

Moving this two-position switch [17, fig. 5-3] from **OFF** to **COMM** energizes the telemeter commutator motor.

FM Telemeter Power Switch

This two-position switch [8, fig. 5-3], when turned from **OFF** to **ON**, energizes the (FM) modulator of the telemeter system.

Physiological Instrumentation Switch

A physiological instrumentation switch [4, fig. 5-3] is on the instrumentation control panel. The switch, labeled "PHYS INST", allows the physiological instrumentation system to be turned on (switch moved up) or off. The switch controls primary DC bus power to the physiological instrumentation system.

Pilot's Blood Pressure Switch

This two-position switch [5, fig. 5-3], when turned from **OFF** to **ON**, energizes the pilot's blood pressure sensors that is part of the physiological instrumentation.

Skylight Hatch Switch

The X-15A-2 has a skylight hatch [16, fig. 3-2] on top of the instrument compartment that gives the instrumentation equipment access to the outside environment. Moving this two-position switch [19, fig. 5-3], on the center pedestal, to **OPEN** opens the skylight hatch on top of the instrument compartment. Moving the switch to **CLOSED** closes the hatch. The switch is powered by the primary DC bus.

Note: The skylight hatch is hydraulically activated. It needs hydraulic power to open or close.

Skylight Hatch Light

When on, this amber press-to-test light [73, fig. 5-1], on the main panel, indicates that the skylight hatch [16, fig. 3-2] on top of the instrument compartment is open. If the light is off, the skylight hatch is closed. The light is powered by the primary DC bus and can be tested by pressing (left-clicking with the mouse) the lamp housing.

Note: The press-to-test lights in the cockpit can be tested by pressing (left-clicking with the mouse) the light housing. Left-clicking with the mouse a second time will return the light to its normal operating state.

Star Tracker Power Switch

The instrument compartment on the X-15A-2 addon carries an ultraviolet "star tracker" [17, fig. 3-2] and an ultraviolet horizon scanner that allow for stellar photography experiments. The star tracker, in the instrument compartment, is powered by the primary DC bus and the No. 2 primary AC bus. Moving this two-position switch [20, fig. 5-3], on the center pedestal, to **ON** energizes the star tracker circuits. Moving the switch to **OFF** electrically de-energizes the star tracker. The switch is powered by the primary DC bus.

INDICATOR, CAUTION AND WARNING LIGHT SYSTEM

Indicator, Caution and Warning Light Test Switch

An indicator, caution, and warning light test switch [38, fig. 5-1], powered by the primary DC bus, is on the instrument panel right wing. This switch has two positions, TEST and NORMAL.

When the switch is placed in the **TEST** position, all indicator, caution, and warning lights (except the fire-warning light [47, fig. 5-1] and the press-to-test lights) on the instrument panel and center pedestal come on; this is only a test of the bulbs. The switch must be at **NORMAL** for all normal operations.

Note: The press-to-test lights in the cockpit can be tested by pressing (left-clicking with the mouse) the light housing. Left-clicking with the mouse a second time will return the light to its normal operating state.

CANOPY

The one-piece, pneumatically counterbalanced, clamshell-type canopy is manually operated and mechanically locked in the down position. The canopy is hinged at the rear and opens about 45 degrees after moving aft to unlock. The canopy can be manually locked from either inside or outside.

The canopy has double-pane (or triple-pane) windows [9, fig. 4-3] with an air space be-

tween the panes for defrosting air. The user can select between the default elliptical windows or the optional trapezoidal windows.

A retractable, adjustable head restraint [8, fig. 4-3] can be lowered from the top of the canopy to restrain the pilot's head during deceleration.

A canopy seal [10, fig. 4-3], incorporated in the rim of the canopy, contacts the canopy sill and a bulkhead at the rear of the cockpit to allow pressurization of the cockpit.

On the real aircraft, a cartridge-type canopy remover is fired by an initiator when the ejection seat armrests [10, fig. 4-2] are raised. Also, this initiator directs some of its expanding gases to extend a thruster at the forward end of the canopy. When the canopy leaves the airplane, it fires the ejection seat catapult initiator to eject the seat.

The canopy can also be ejected with the canopy internal emergency jettison "T" handle [32, fig. 5-1] which fires a separate initiator that does not arm and fire the ejection seat when the canopy leaves. A similar "T" handle is provided externally, behind a door [26, fig. 3-1] on the right side of the fuselage, just below the canopy split line, for ground emergencies.

Note: The canopy and the seat cannot be ejected in this software version.

An interesting feature of the virtual cockpit is the possibility to make the canopy "invisible"

to create the impression that the aircraft is equipped with a bubble glass canopy. Though not realistic in the case of the X-15, the invisible canopy mode gives the pilot a better outside view, especially during landing.

To make the canopy invisible, simply pull (drag with the mouse) the yellow canopy internal emergency jettison "T" handle [32, fig. 5-1] on the instrument panel right wing (see below). Note that the internal canopy emergency jettison handle does not open the canopy. It simply makes it invisible while the simulator thinks it's still on. To open or close/lock the canopy, use the canopy internal handle [26, fig. 4-1] (see below).

Note: The canopy also becomes invisible on the external model.

For more information about how to switch windows or make the canopy and other parts invisible in the virtual cockpit, refer to "How to Switch Window Types and Configure the VC".

Canopy Seal

An inflatable rubber seal [10, fig. 4-3], built into the edge of the canopy frame, seats against mating surfaces of the canopy sill and a bulkhead at the aft end of the cockpit to provide sealing for cockpit pressurization. The seal pressurization valve is mechanically actuated just before the complete locking of the canopy to permit gaseous nitrogen to inflate the seal. When the canopy internal handle [26, fig. 4-1] is actuated to open the canopy, the seal pressurization is dumped and the nitrogen valve is closed.

Canopy External Handle

On the real aircraft, the canopy external handle, on the right side of the fuselage, below the forward end of the canopy, is behind a flush door [26, fig. 3-1] that is opened by pushing a flush-mounted button just aft of the door. Pulling the black long-hinged handle out of its spring clip and rotating it upward unlocks and moves the canopy aft about one inch to permit manual raising of

the canopy. Rotating the handle forward and down moves the canopy forward and locks it. Pushing the handle into the spring clip stows the handle.

Canopy Internal Handle

The canopy internal handle [26, fig. 4-1], for locking or unlocking the canopy, is on the right side of the cockpit, just below the canopy sill. Locking of the canopy requires that the canopy be lowered manually until it is tight against the canopy sill, then the handle pushed forward until it is against the stops and then rotated outboard to lock. Unlocking the canopy is accomplished by pulling the handle inboard and aft all the way back against the stops until the canopy is unlocked. The canopy can then be raised manually. During the ejection sequence, the handle automatically moves aft when the canopy unlocks.

To open or close/lock the canopy from the virtual cockpit, simply click on the white handle. You can also use the simulator's "**SHIFT-E**" keyboard shortcut.

Warning

- Keep hands and arms clear of canopy internal handle when canopy is jettisoned, because the canopy handle moves aft with considerable force.

Canopy Internal Emergency Jettison Handle

On the real aircraft, the canopy internal emergency jettison handle [32, fig. 5-1], on the instrument panel right wing, jettisons the canopy without firing the seat. The "T" handle fires a separate initiator that fires the canopy remover and extends the canopy thruster. On the ground, the handle is safetied with a safety pin inserted through the handle.

The seat is not armed when the canopy is removed by this means.

Note: The canopy and the seat cannot be ejected in this software version.

Pulling (dragging) this handle in the virtual cockpit will make the canopy "invisible". Note that the canopy internal emergency jettison handle does not open the canopy. It simply makes it invisible while the simulator thinks it's still on. To open or close/lock the canopy, use the canopy internal handle [26, fig. 4-1].

For more information about how to make the canopy invisible in the virtual cockpit, refer to "How to Change the Windows and Configure the VC".

Note: The canopy also becomes invisible on the external model.

Warning

- Keep hands and arms clear of canopy internal handle when pulling the emergency jettison handle, because the canopy internal handle moves aft with considerable force.

Canopy External Emergency Jettison Handle

On the real aircraft, the canopy may be jettisoned from the outside by the canopy external emergency jettison handle.

This yellow, T-type handle is just forward of the canopy external handle in a recess behind a flush door [26, fig. 3-1] on the right side of the fuselage, below the forward end of the canopy.

When the handle is pulled straight out approximately 4 inches with a force of about 10 pounds, a canopy initiator is fired. This in turn fires a canopy remover that forcibly jettisons the canopy.

Note: The canopy and the seat cannot be ejected in this software version.

Warning

- The canopy external emergency jettison handle does not have an extension lanyard. Therefore, extreme care should be taken to ensure that no part of a person's body is directly over any portion of the canopy when it is jettisoned.

- If the ejection handles are raised and the canopy has not jettisoned, the ejection seat must be deactivated before the canopy is either manually opened or jettisoned, to prevent seat ejection.

Safety Pins

Because of the interdependence of the seat and canopy ejection systems, the seat and canopy safety pins are discussed together in this paragraph.

Note: There are no safety pins in this software version.

On the real aircraft, to safety the canopy and seat ejection systems adequately, seven safety pins are required.

The two initiators on the canopy deck, just aft of the right side of the seat, and the two initiators on the right side of the seat near the headrest are safetied by a safety pin inserted through a hole in the initiator sear pin of each initiator.

The right-hand ejection handle, on the ejection seat, restraint emergency release handle on the ejection seat, and canopy internal emergency jettison handle on the instrument panel right wing are safetied with a safety pin

through a hole in each handle.

Warning

- All safety pins must be removed before flight and replaced after landing.

EJECTION SEAT
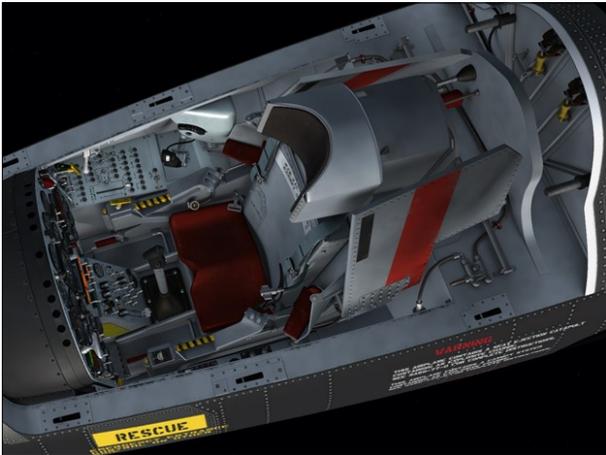
On the real aircraft, the ejection seat is designed to permit safe pilot ejection up to Mach 4.0, in any attitude, and at any altitude up to 120,000 feet.

Firing of the seat is initiated by jettisoning the canopy. The seat cannot be ejected unless the canopy has left the airplane.

Note: The ejection seat on the X-15A-2 addon is highly detailed and has some animated features (see below). However, it cannot eject from the cockpit in this software version. Animating and programming the complex ejection method used on the X-15 airplane, including modeling the parachutes, was beyond the scope of this project.

A ballistic-rocket type catapult supplies the necessary propulsion force to eject the seat and pilot from the airplane. During ejection, stabilizing fins [8, fig. 4-2] and booms automatically extend to stabilize the seat. Restraint devices [5, 9, 10, 15, 17, fig. 4-2] are provided for the pilot's body and legs to prevent injuries and separation from the seat above 15,000 feet. At this altitude, an aner-

oid device fires three initiators to free the restraint devices and permit pilot separation from the seat. A manual handle is provided to permit the pilot to release the restraints if the aneroid device fails. If ejection below 15,000 feet is accomplished, there is a 3-second delay after ejection before automatic pilot-seat separation is initiated.

The breathing oxygen supply is contained in cylinders mounted to the underside of the seat [4, fig. 4-2] and is used when the airplane is launched from the carrier airplane. While in captive flight, breathing oxygen is supplied by the carrier airplane. An oxygen selector valve and gauge [18, fig. 4-2] on the left side of the seat permits selection of either carrier airplane oxygen or the seat-contained oxygen.

The personal leads [12, fig. 4-2] (radio, oxygen, and ventilated suit) are attached to a disconnect block that is fitted into a disconnect fitting on the left side inside the seat bucket. The ejection seat also has a quick-disconnect receptacle [12, fig. 4-2] to plug in the pilot's physiological instrumentation wiring harness. The receptacle is on the top of the seat pan in the forward right-hand corner.

The manually adjustable shoulder harness straps [5, fig. 4-2] are fastened to the integrated parachute restraint harness with quick-disconnect fittings. During the ejection sequence, the shoulder harness is released when the headrest [1, fig. 4-2] ejects. The pilot's parachute is carried in a container [3, fig. 4-2] attached to the pilot's integrated
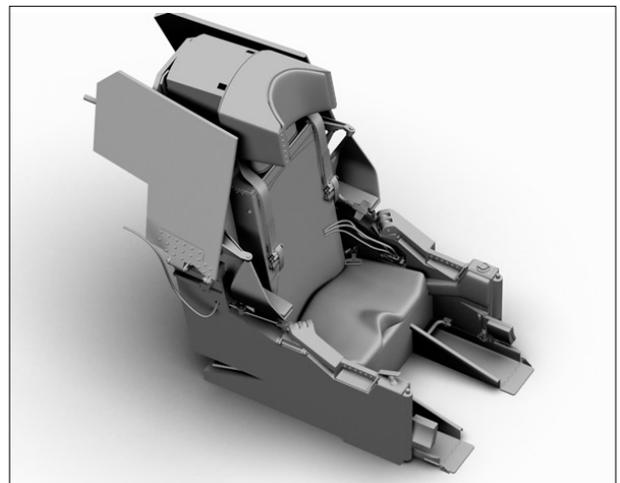
harness, with a pilot chute in a separate container [2, fig. 4-2]; the pilot chute is released when the headrest is ejected. The operation sequence of the aneroid device is actuated at 15,000 feet, and it fires the three initiators that fire the headrest and release the seat belt, personal leads, ejection handles, and all restraints, to permit pilot separation from the seat.

Seat Initiator Hose Cutter Handle

This red handle, flush-mounted on the right side of the fuselage, contains a cutter mechanism that is an integral part of the handle. The seat initiator hose is routed through a slotted spindle, which actually is the pivot point of the handle. When the handle is pulled outward, a sleeve rotates on the spindle to force the sharp edges of the slot against the hose. As the hose is cut, the cutter acts as a block that prevent the passage of expanded gasses that could otherwise make their way to the seat catapult if the loose hose ends were aligned. In its stowed position, the handle is secure at the lower end by a quick-acting fastener that can be released with counterclockwise turn of a screwdriver.

Ejection Handles

On the real aircraft, unlatching and raising either ejection handle on the seat [10, fig. 4-2] to within 15 degrees of its full travel fires an initiator that fires the canopy remover. As the canopy leaves the airplane, it fires the seat catapult initiator that fires the two-stage seat catapult.

The ejection handle release latch is in the top portion of each ejection handle and is actuated when either ejection handle is grasped. Since the ejection handle assemblies are linked together by a linkage to a torque tube, pulling up on either ejection handle automatically raises the other. The ejection handles lock in the full travel position until unlocked by the restraint release system. If the canopy is inadvertently lost in flight, the seat will not eject unless the ejection handles are raised. During pilot separation from the seat after ejection, the ejection handle assemblies are automatically unlocked and swing out board to permit unrestricted pilot separation from the seat.

Modified ejection seats and pressure suits provide automatic actuation of the pilot's emergency oxygen supply when the ejection handles are raised. As the handles are raised, a cable pulls the pin from the emergency oxygen supply valve. The cable is attached in parallel with the manual actuation cable.

Note: Clicking either ejection handle in the virtual cockpit with the mouse will make them travel up or down. The ejection handles are not animated on the exterior model. The canopy and the seat cannot be ejected in this software version (see above).

Restraint Emergency Release Handle

On the real aircraft, a restraint emergency release handle [13, fig. 4-2], on the right side of the ejection seat, is pulled up to afford a quick release from the seat on the ground when the manual release would be too slow, or after ejection if the aneroid device fails to actuate the automatic restraint release system. Pulling this handle releases the foot restraints [15, fig. 4-2], lap belt [11, fig. 4-2], personal leads [12, fig. 4-2], and armrest assemblies [9, fig. 4-2], and fires the headrest [1, fig. 4-2] which releases the shoulder harness [5, fig. 4-2].

Note: Pulling (dragging with the mouse) this yellow handle in the virtual cockpit will release the foot restraints and move the ejection handles [10, fig. 4-2] to their normal position.

Foot Restraint Release Buttons

The foot restraint release buttons [14, fig. 4-2] are on the top front corners of the seat, above each foot restraint [15, fig. 4-2]. Depressing each button unlocks its respective foot restraint, which releases the pilot's feet. During automatic pilot-seat separation, the foot restraints unlock automatically.

Note: Clicking either yellow foot restraint release button in the virtual cockpit will release or lock the foot restraints.

PARACHUTE, INTEGRATED RE-STRAINT EQUIPMENT AND PRES-SURE SUIT

On the real aircraft, the personal parachute for the pilot is contained within a fiber glass parachute container [3, fig. 4-2] that is attached to the pilot's integrated harness at the top and bottom.

The parachute may be either a 24-foot or a 28-foot type. Another fiber glass container [2, fig. 4-2] contains the pilot chute and, along with the parachute container lids, closes the top of the parachute container. The pilot chute container is held in place by a retaining pin that locks into the manual ripcord pin. On the top of the container, a retainer pin fits into the ejection seat headrest [1, fig. 4-2]. During ejection, the pilot chute container is locked to the headrest as the seat leaves the airplane, and is pulled off the parachute container to deploy the pilot chute when the headrest is fired. This in turn pulls out the main parachute canopy.

A rescue beacon transmitter, installed in the parachute container, is automatically energized into continuous operation when the pilot's parachute deploys. The transmitter antenna is attached to one of the parachute straps. Transmission is on the X-15 telemetering frequency of 244.3 megacycles. The transmitter permits ground stations to obtain position fixes on the pilot after an ejection.

Note: The canopy and the seat cannot be ejected in this software version. Animating and programming the complex ejection

method used on the X-15 airplane, including modeling the parachutes, was beyond the scope of this project.

The parachute container is attached to the seat by a strap on the lower corner of each side. This strap is attached to a fitting which is held by a lap belt release on each side in the seat bucket. This release hinges on a pip pin [11, fig. 4-2] during automatic release, but can be removed manually to permit removal of the parachute container without actuating the restraint release system. When pilot-seat separation occurs during ejection, the parachute container remains with the pilot.

The parachute riser [5, fig. 4-2] quick-release buckles also fasten the shoulder harness and parachute container to the pressure suit fittings, on the pilot's chest, just below the shoulders. The rip cord "D" ring is attached to a strap fastened to the left side of the parachute container. This strap also has a quick-release buckle which is fastened to a fitting on the left side of the integrated restraint harness, just below the arm.

The lap belt portion of the integrated restraint harness consists of two straps, one over each hip, fitted with hooks that are snapped into a ring portion of the lap belt release fitting on either side of the seat. The lap belt has double adjuster straps, one through each side of the buckle. The adjuster straps must be pulled tight to keep the pilot firmly in the seat. This attaches the pilot to the seat and parachute container.

The full pressure suit was modified for the X-15 airplane and has the restraint straps and parachute harness designed as an integral part of the suit. A neck seal is used to keep the suit pressurization nitrogen and breathing oxygen separated.

Attached to the back of the restraint harness is a controller back pan which incorporates an oxygen regulator, suit pressure regulator, anti-G valve, and the emergency oxygen supply for breathing and suit emergency pressurization. This emergency oxygen supply is sufficient for about 20 minutes after the pilot separates from the ejection seat. On some pressure suits, the oxygen and communica-

tion lines from the controller back pan are internal and plug into a pressure suit mating receptacle over the left shoulder blade. In other types of suits, they connect to the helmet. The personal-lead disconnect block is also attached to the controller back pan. The suit regulator ventilation exhaust valve is over the right shoulder blade (controls are also provided on some helmets).

The emergency oxygen supply in the controller back pan is actuated automatically when the seat ejection handles [10, fig. 4-2] are raised, or can be actuated manually by a green ball on the right side of the suit. The helmet is free-rotating and is fastened to the suit with a snap connector ring that seals the joint. The helmet visor is locked down with a squeeze latch on the bottom edge.

When the visor is down and latched, the suit and helmet are completely sealed in a leak-proof unit. The visor is kept fog-free by the breathing oxygen as it comes in around the face opening and across the visor.

Warning

- If the pilot prebreathes 100 percent oxygen before entering the cockpit, the visor must not be opened at any time during ground or flight operations; otherwise, the de-nitrogenation effect will be nullified.

AUXILIARY EQUIPMENT

AIR CONDITIONING AND PRESSURIZATION SYSTEM

The air conditioning and pressurization system utilizes either liquid nitrogen or ram air as a cooling and pressurization medium.

The liquid nitrogen is supplied from the X-15 storage tank during free flight and from either the X-15 storage tank or the carrier airplane pylon tank during captive flight. The X-15 tank can supply the entire air conditioning and pressurization system and when used will supply liquid nitrogen for pressurizing and cooling the cockpit and No. 2 electronic

equipment compartment, and for cooling for the AC generators, APU upper turbine bearings, stable platform, and ball nose. It will also supply nitrogen gas for inflating the canopy and equipment compartment seals, purging the hydraulic reservoirs, between-panel purging of the windshield, and ventilation of the pilot's pressure suit.

The nitrogen gas used for between-panel windshield purging and pilot's pressure suit ventilation is supplied through a common liquid nitrogen supply line which contains a heat exchanger and electric heater for converting the liquid to gaseous nitrogen.

The carrier airplane pylon tank and associated controls make up the augmented cooling system. The primary function of this system is to augment the cooling to the stable platform during ground operation and taxiing, when the blowers are circulating compartment air, and when ram air is used during climb to cruise altitude. The augmented system is also used for between-panel windshield purging and pilot's pressure suit ventilation during these times and can be used for cooling the No. 2 electronic equipment compartment and ball nose.

The ram-air system is limited in its operation to cooling the cockpit and the electronic equipment compartment. The ram-air system, with augmented cooling, is used during climb and cruise. The X-15 liquid nitrogen system is turned on at the beginning of cruise-climb to launch altitude.

Note: If the ram-air system does not provide adequate cockpit cooling during captive flight at altitude, the augmented cooling system liquid nitrogen supply can be used to increase cooling by turning off the ram-air system and turning on the blowers.

The ram-air system should not be used above 35,000 feet or at speeds in excess of Mach 1.0, because of possible damage to the ram-air scoop [21, fig. 3-1] and ducting due to high or excessive air loads and temperatures too high for proper electronic equipment cooling. During free flight, ram air may be used as an emergency measure if the X-15 liquid nitrogen system fails or during descent when the liquid nitrogen system has been

depleted, but the limitation of Mach 1.0 must be observed.

The cockpit and the electronic equipment compartment are pressurized to 3.5 psi by the use of nitrogen after it has been converted from liquid to gaseous state. The X-15 liquid nitrogen is stored under pressure and is converted as required for cockpit and equipment cooling and pressurization. A cockpit pressure regulator automatically maintains a pressure of 3.5 psi at 35,000 feet and above. From the ground up to 35,000 feet, the cockpit pressure remains the same as the outside pressure. If the cockpit pressure regulator does not operate properly, a cockpit safety valve will not allow the cockpit pressure to exceed 3.8 psi; also, during a rapid descent, the safety valve will prevent a pressure differential greater than 0.5 psi.

Pilot comfort is provided by the David Clark A/P22S-2 pressure suit, which maintains a regulated pressure of 3.6 psi over the entire body. Pressure to the suit is provided by the air conditioning and pressurization system. Temperature control of the nitrogen flow through the suit is maintained by an electric heater which is adjusted to a pilot-selected range. The temperature of the gas supplied to the pressure suit is from 55°F (±5°F) to 90° F (±5°F).

The X-15 air conditioning and pressurization system may be considered automatic to the extent that once it has been started and manually regulated for desired flow and temperature, it will continue to operate without further adjustment.

COCKPIT AIR CONDITIONING AND PRESSURIZATION

Cockpit air conditioning and pressurization is by either of two systems: the ram-air system, or the liquid nitrogen air conditioning and pressurization system of the X-15 airplane.

The ram-air system, although it does not pressurize the cockpit and the No. 2 electronic equipment compartment, will furnish adequate cooling for these areas. Approximately 10 percent of the ram-air flow may be diverted to the cockpit by a cockpit control [11, fig. 5-3], with the remaining 90 percent being routed through a plenum, from which it is ducted to the No. 2 electronic equipment compartment. Flapper-type shutoff valves prevent the ram-air flow from entering the mixing chambers and blower ducts of the cooling system. The ram-air system must not be operated at the same time as the X-15 nitrogen system.

The X-15 liquid nitrogen system actually cools and pressurizes simultaneously. A vacuum-type contained in the No. 3 equipment compartment stores 176 pounds, or 26.5 gallons, of liquid nitrogen, which is depleted at a normal usage rate of approximately 5 pounds per minute. A pressure relief valve mounted in the nitrogen line between the top of the container and the nitrogen vent and build-up valve is preset to vent at 80 (+0, -4) psi.

Helium gas for pressurizing the X-15 liquid nitrogen tank is stored in a spherical tank in the No. 3 equipment compartment. Helium pressure is reduced from approximately 4200 psi at the tank to approximately 67 psi through a differential-pressure regulator. The helium gas is then routed into the top of the liquid nitrogen tank. The liquid nitrogen is forced out of the bottom of the tank and on through the system to the injectors. The liquid nitrogen is forced under pressure through the injectors into a stream of returning gaseous nitrogen within the mixing chambers, where it is mixed and recirculated.

The temperature of the air conditioning system is automatically controlled by the two thermostats that regulate the flow of nitrogen vapor from the liquid nitrogen injectors. The thermostats and the liquid nitrogen injectors are part of the system mixing chambers that connect with the plenum from which the regulated cooling gas is ducted to the electronic equipment requiring direct cooling.

The air conditioning and pressurization system includes an alternate system which automatically pressurizes the cockpit if component malfunctions result in loss of pressure. The alternate system includes a pressure switch, a solenoid-operated shutoff valve,

two heat exchangers, and associated plumbing. When the alternate system is armed and the pressure switch contacts close (cockpit altitude rises above approximately 37,000 feet), the solenoid-operated shutoff valve is energized open. This allows liquid nitrogen to flow to a heat exchanger in each APU compartment. The nitrogen is converted to a gaseous state and expelled into the cockpit. The pressure switch contacts open when cockpit altitude drops below approximately 36,000 feet.

The augmented cooling system liquid nitrogen supply in the carrier airplane pylon is contained within a 6-cubic-foot tank. Approximately 292 pounds of liquid nitrogen is pressurized to approximately 63 psi by nitrogen pressure in the carrier airplane gaseous nitrogen system. Flow of the augmented cooling system liquid nitrogen to the X-15 is controlled from the launch operator's panel in the carrier airplane.

Hazards of Gaseous and Liquid Nitrogen

Gaseous nitrogen is an odorless, colorless gas used in the X-15 aircraft for cooling and pressurizing. Nitrogen is chemically inactive. The gas isn't corrosive, explosive, nor combustible.

The only possible hazards arising from the use of gaseous nitrogen stems from (1) high storage and transfer pressures normally employed, or (2) shortage of breathing oxygen because of extremely high concentrations of the gas.

The only physiological hazard to be considered in handling liquid nitrogen is the effect of the extreme cold, which destroys living tissue and produces an injury similar to a burn. In addition, freezing can restrict blood circulation and cause gangrene, especially in the extremities. Sufficient liquid nitrogen splashed into the eyes will cause blindness.

AIR CONDITIONING AND PRESSURIZATION SYSTEM CONTROLS AND INDICATORS

Pressure-Cooling Lever

The pressure-cooling lever [9, fig. 5-9], on the right console, controls both the air conditioning and pressurization of the cockpit and the electronic equipment compartments. The lever has two positions, ON and OFF.

When the lever is moved forward to **ON**, the system manual shutoff valve opens, allowing liquid nitrogen to flow throughout the entire system. With the lever at **OFF**, the system is inoperative.

In free flight, the nitrogen gas for the pilot's pressure suit system is also controlled by the pressure-cooling lever.

Alternate Cabin Pressurization Switch

This 2-position switch [27, fig. 5-9], on the right console, controls primary DC bus power to the alternate cabin pressurization system shutoff valve.

The switch, labeled "ALT CABIN PRESS", turns on the alternate cabin pressurization system arming circuit when set to **ON**. When the switch is at **OFF**, the alternate cabin pressurization system arming circuit is de-energized.

Blower Switches

There are two blower toggle switches [10, fig. 5-9] on the right console. The three-position switches, powered by the primary DC bus, are labeled "BLOWERS".

When the switches are at **OFF**, the blowers are off, the liquid nitrogen shutoff valves to the injectors are de-energized open, and the pressure control valves are de-energized closed.

With the switches at **BLOWER & LN$_2$**, electrical power is applied to the blowers, the liquid nitrogen shutoff valves to the injectors are de-energized open, and the pressure control valves are energized open.

With the switches at **BLOWER ONLY**, electrical power is applied to the blowers, the liquid nitrogen shutoff valves to the injectors are energized closed, and the pressure control valves are de-energized closed.

Both the No. 1 and No. 2 blowers are powered by the No. 1 primary AC bus. The No. 1 and 2 solenoid shutoff valves are powered by the primary DC bus. The blowers are protected by circuit breakers on the circuit-breaker panel.

Cabin Source Helium Shutoff Valve Switch

Helium tank pressure to the liquid nitrogen tank is controlled by a two-position toggle switch on the circuit-breaker panel [11, fig. 5-9] on the right console. The switch is labeled "CABIN SOURCE He S/O VALVE".

With the switch at **CLOSED**, primary DC bus power closes a solenoid-operated shutoff valve in the helium line upstream of the helium tank. With the switch at **OPEN** (forward), the solenoid-operated shutoff valve in the helium line is de-energized to the open position. The valve is used to isolate the air conditioning and pressurization system helium supply from the main propellant helium source as long as the former remains at or above 3000 psi. If the air conditioning and pressurization system helium supply drops below 3000 psi before launch, the valve should be opened to top off the helium supply.

Windshield Antifogging Handle

This unlabeled (yellow) handle [2, fig. 4-3] is used to position a valve which controls flow of gaseous nitrogen to the inner surface of the windshield inner panels. It is on the right side of the canopy, below the windshield panel.

Flow of the nitrogen is shut off with the handle rotated down. Rotating the handle counterclockwise 90 degrees (to horizontal) opens the valve and permits flow of X-15 or augmented system gaseous nitrogen to the windshield antifogging manifold.

Note: In the virtual cockpit, windshield frost or fogging will melt in about 10 seconds after moving the windshield heater switches [36, fig. 5-1] to **ON** or turning the windshield antifogging handle to horizontal. The switches and the handle will respond to a single mouse click.

Windshield Purge Handle

This unlabeled (gray) handle [3, fig. 4-3] is used to position a valve which controls purging flow of gaseous nitrogen between the windshield panels. The handle is on the right side of the canopy, below the windshield panel.

Flow of the purging gas is shut off with the handle rotated down. Counterclockwise rota-

tion of the handle 90 degrees (to horizontal) opens the valve and permits purging gas flow.

Ram-Air Lever

A ram-air lever [16, fig. 5-3], on the left side of the center pedestal, controls the operation of the ram-air system. It is labeled "RAM AIR" and has OPEN and CLOSED positions. The lever is mechanically linked to the ram-air scoop [21, fig. 3-1] and the ram-air shutoff valve, and electrically connected to the cockpit safety (dump) valve. The ram-air scoop is on the lower center line of the fuselage, just aft of the nose wheel well.

When the lever is moved (dragged with the mouse) to **OPEN**, the ram-air shutoff valve and the ram-air scoop are opened to allow ram air to enter the system. At the same time, the cockpit safety valve is opened, allowing the cockpit and electronic equipment compartment pressure to be depleted and the ram air to be circulated through these areas.

When the lever is at **CLOSED**, the ram-air shutoff valve and the ram-air scoop close. The cockpit safety valve is closed when the ram-air lever is at **CLOSED**.

Cockpit Ram-Air Knob

Ram air to the cockpit is controlled by the cockpit ram-air knob [11, fig. 5-3], on the center pedestal. The knob is mechanically linked to a shutoff valve that is ducted off the main ram-air line. When the knob is pulled (dragged with the mouse) straight out, the two-way shutoff valve opens to allow ram air (if the ram-air lever [16, fig. 5-3] is at **OPEN**) to enter the cockpit. Pushing the knob in closes off the ram air to the cockpit.

The cockpit ram-air knob should be pushed in when the X-15 liquid nitrogen system is in use (blower switches [10, fig. 5-9] at **BLOWER & LN$_2$**); otherwise, recirculating cooling gas will be bled from the ducting system.

Cabin Helium Source Pressure Gauge

A cabin helium source pressure gauge [40, fig. 5-1], on the lower right of the instrument panel, indicates the helium pressure available to operate the air conditioning and pressurization system. The gauge is calibrated from 0 to 5000 psi. The gauge and pressure transmitters are powered by the 26-volt AC bus and protected by a circuit breaker [12, fig. 5-9] on the circuit-breaker panel on the right console.

Mixing Chamber Temperature Gauge

The dual-pointer mixing chamber temperature gauge [42, fig. 5-1] shows the temperature in the No. 1 and No. 2 mixing chambers. Power is supplied by the No. 1 primary AC bus to amplifiers within the gauge unit, activating the indicator needles. The gage shows temperature in degrees centigrade and is calibrated in 10° C increments from -80° C to +80 ° C.

Cabin Pressure Altimeter

The pressure altitude of the cockpit is shown by a cabin pressure altimeter [41, fig. 5-1] on the lower right corner of the instrument panel. The indicator is vented only to pressure within the cockpit, and operates on the aneroid principle.

OPERATION OF AIR CONDITIONING AND PRESSURIZATION SYSTEM

Operation of Augmented Cooling System

To operate the augmented cooling system, proceed as follows:

1. Cabin helium source shutoff valve switch [11, fig. 5-9] - **OFF**.

2. APU cooling switch [17, fig. 5-9] - **SINGLE** .

3. Pressure cooling lever [9, fig. 5-9] - **OFF**.

4. Windshield antifogging handle [2, fig. 4-3] - **OFF**.

5. X-15 LN_2 supply switch (B-52) - Check **OPEN**. Check with launch operator that switch is at **OPEN**.

6. Vent suit heater switch [6, fig. 5-4] - **HIGH** or **LOW**.

7. Pressure suit ventilation knob [5, fig. 5-4] - **As required**. Knob should be open a minimum of one turn.

8. Stable platform LN_2 cooling control switch (B-52) - Check **OFF**. Check with launch operator that switch is **OFF**.

9. Ram-air lever [16, fig. 5-3] - **CLOSED**.

10. Blower switches [10, fig. 5-9] - **BLOWERS & LN₂** .

11. Mixing chamber temperature gage [42, fig. 5-1] - **CHECK**. When both chamber temperatures stabilize at -40˚ C (±5˚ C), proceed to step 12.

12. Stable platform switch [33, fig. 5-1] - **EXT**. Move stable platform switch to **EXT** and wait 10 minutes before proceeding to step 13.

13. Blower switches [10, fig. 5-9] - **BLOWER ONLY**.

14. Stable platform LN_2 cooling control switch (B-52) - Check **ON**. Check with launch

operator that switch is **ON**.

Operation of Ram-Air and Augmented Cooling System (Captive Flight)

To operate the ram-air and augmented cooling systems, proceed as follows:

1. Cabin source helium shutoff valve switch [11, fig. 5-9] - **OFF**.

2. APU cooling switch [17, fig. 5-9] - **SINGLE**.

3. Pressure cooling lever [9, fig. 5-9] - **OFF**.

4. X-15 LN_2 supply switch (B-52) - Check **OPEN**. Check with launch operator that switch is **OPEN**.

5. Stable platform LN_2 cooling control switch (B-52) - Check **OFF**. Check with launch operator that switch is **OFF**.

6. Blower switches [10, fig. 5-9] - **OFF**.

7. Ram-air lever [16, fig. 5-3] - **OPEN**.

Operation of X-15 Liquid Nitrogen System

To operate the X-15 airplane liquid nitrogen system at prelaunch, proceed as follows:

1. Ram-air lever [16, fig. 5-3] - **CLOSED**.

2. Cabin source helium shutoff valve switch [11, fig. 5-9] - **CLOSED**.

3. APU cooling switch [17, fig. 5-9] - **NORMAL**.

4. Alternate cabin pressurization switch [27, fig. 5-9] - **ON** (down).

5. Pressure-cooling lever [9, fig. 5-9] - **ON**.

6. Vent suit heater switch [6, fig. 5-4] - **HIGH** or **LOW**.

7. Pressure suit ventilation knob [5, fig. 5-4] - **As required**.

8. X-15 LN$_2$ supply switch (B-52) - Check **CLOSE**. Check with launch operator that switch is at **CLOSE**.

9. Blower switches [10, fig. 5-9] - **BLOWER & LN$_2$**.

Note: The windshield heater switches should be moved to ON (up) when fogging or frosting of the glass is observed and should remain ON (up) until the airplane is landed.

Emergency Operation of Ram-Air System (After Launch)

To operate the ram-air system, proceed as follows:

1. Cabin source helium shutoff valve switch [11, fig. 5-9] - **OPEN**.

2. Pressure-cooling lever [9, fig. 5-9] - **ON**.

3. No. 1 and 2 blower switches [10, fig. 5-9] - **OFF**.

4. Ram-air lever [16, fig. 5-3] - **OPEN**.

Note: Do not operate the blowers and the ram-air system simultaneously.

Warning

■ Do not open the ram-air scoop when the airplane is above 35,000 feet or the airspeed is in excess of Mach 1.0; otherwise, the ram-air scoop will be subjected to excessive air loads and be damaged. If the ram-air lever is opened, cockpit pressure will be dumped through the cockpit safety valve.

GENERATOR AND APU COOLING AND PRESSURIZATION

The two AC generators and APU upper turbine bearing areas are cooled and pressurized by gaseous nitrogen after it has been converted from a liquid state.

When the pressure-cooling lever [9, fig. 5-9] and cockpit helium switch [27, fig. 5-9] are

ON, X-15 system liquid nitrogen flows to two normally open shutoff valves, one for each generator cooling shroud and each APU upper turbine bearing area. These valves are electrically connected to the APU switches [17, 30, fig. 5-1] so that when either APU switch is turned **OFF** while the APU cooling switch [17, fig. 5-9] is at **SINGLE**, its respective valve closes. This shuts off the liquid nitrogen supply to the affected units regardless of the position of the pressure-cooling lever.

After passing through the shutoff valves, the liquid nitrogen is routed to pressure restrictors, where it is changed to a gaseous state before moving on to the generators and turbines. The gaseous nitrogen, after it has absorbed heat from the generator and APU upper turbine bearing area, is exhausted into the APU compartment.

APU Nitrogen Cooling Switch
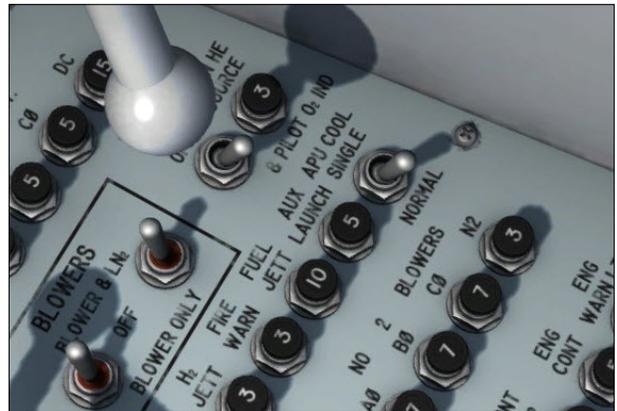
This two-position switch [17, fig. 5-9], at the aft end of the right-hand console, is labeled "APU COOL". It is powered from the primary DC bus through the APU switches [17, 30, fig. 5-1].

With the switch at **NORMAL**, primary DC bus power is cut off from the shutoff valves which control liquid nitrogen flow to the APU's and AC generators, and the valves are de-energized open.

With the switch at **SINGLE**, each valve will be energized closed if its respective APU switch is **OFF**, or de-energized open if its respective APU switch is **ON**.

During single-APU operation, if excessive upper bearing temperatures are encountered on the operating APU, the switch should be moved to **NORMAL**. This will increase the volume of liquid nitrogen flow through individual flow restrictors, thus providing more efficient cooling of the bearing. If the upper bearing temperature of the non-operating APU is excessively low, the switch should be moved to **SINGLE**, to shut off cooling nitrogen flow to the non-operating APU.

Caution

■ If moving the switch to **SINGLE** results in excessive upper bearing temperatures on the operating APU, the switch must be returned to **NORMAL**, and if necessary, the non-operating APU restarted.

WINDSHIELD HEATING SYSTEM

Windshield frost or fogging is eliminated by a combination of heated nitrogen gas between the two glass panels and a heater element within each inner glass panel.

A 1/4-inch line from the pilot's pressure suit supply line discharges a constant flow of heated nitrogen gas between the panels to dissipate moisture which may have collected in this area. Each heated inner panel is controlled by a toggle switch.

Windshield Heater Switches

Two adjacent, two-position toggle switches [36, fig. 5-1], labeled "WINDSHIELD HEATER", control primary DC power to the windshield heater elements, one for each side panel. The switches are located in the lower right corner of the instrument panel right wing. When the switches are moved **ON** (up), primary DC bus power is applied to the heater elements.

Note: In the virtual cockpit, windshield frost or fogging will melt in about 10 seconds after moving the windshield heater switches to **ON** or turning the windshield antifogging handle [2, fig. 4-3] to horizontal. The switches and the handle will respond to a single mouse click. You may have to open the
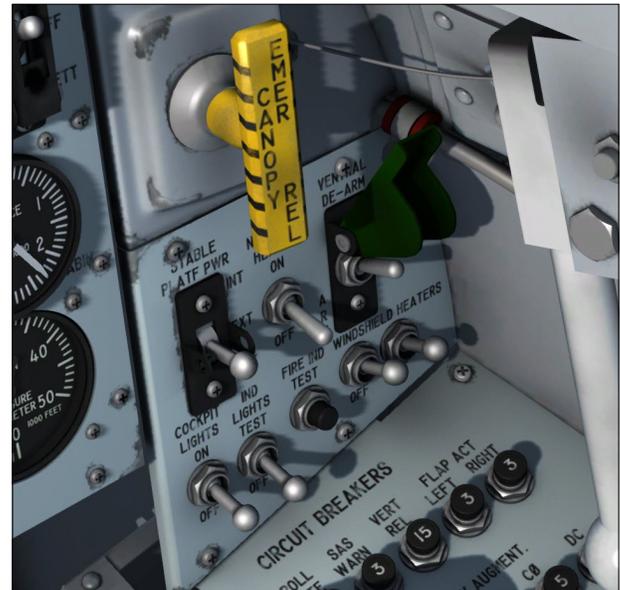
[ventral arming switch guard [35, fig. 5-1] to access the two windshield heater switches on the instrument panel right wing.

COMMUNICATION AND ASSOCIATED ELECTRONIC EQUIPMENT

This section differs from the original X-15 manual to conform to the operation of the radio-communication and navigation equipment available in the simulator. On the real X-15, the radio-communication system operated in the UHF band.

The radio in the virtual cockpit, while keeping the look and fell of the original X-15 radio, was modified to make it compatible with the VHF radio of the simulator and to offer additional radio-navigation features.

RADIO-COMMUNICATION AND ADF/ VOR SYSTEMS

Note: This section differs from the original X-15 manual to conform to the operation of the radio-communication and navigation equipment available in the simulator.

The VHF, ADF and VOR radio-communication and navigation systems installed on the X-15A-2 SE addon enable the pilot to transmit and receive voice transmissions and to obtain visual course reference on the (optional) radio-magnetic indicator (RMI).

The system operates on a main channel and an auxiliary channel. During normal operation, the VHF transmitter and main receiver ("MAIN") are used with a VHF antenna for communication, and the auxiliary receiver ("AUX") is used with the ADF antenna for automatic direction finding (ADF) on the RMI. The system also provides VHF omni-directional radio range (VOR) navigation on

the RMI and a second transceiver for voice transmissions.

The system has a dual power supply, which gives the equipment continuous operation if one of the power sources fails. The main power source for the system is the three-phase AC and the 28-volt DC systems, and protection is afforded by circuit breakers.

RADIO-COMMUNICATION AND ADF/ VOR CONTROLS

Controls for operation of the VHF communication and ADF/VOR systems are on the radio control panel, on the left console.

Note: This section differs from the original X-15 manual to conform to the operation of the radio-communication and navigation equipment available in the simulator.

Radio Function Selector Switch (Avionics Power Switch)

A rotary-knob type selector switch [1, fig. 5-8], on the radio control panel, controls the mode of operation, on the main or auxiliary system (channel), and also selects the antenna of best reception.

The switch is marked "MAIN REC" and "AUX REC" and has a two-headed arrow across the full diameter of the rotary knob.

On the outer perimeter of the knob is the position marking denoting the function of the system. OFF, TR1 (COM1), ADF and VOR (NAV1) are the positions for the main transceiver; TR1 (COM1), TR2 (COM2), ADF and OFF are the positions for the auxiliary transceiver.

The switch is designed so that when the arrow indicates OFF on the main system, the opposite arrow is indicating OFF on the auxiliary system.

With the switch in the **TR1 (COM1)** position on the VHF transceiver, the auxiliary receiver is at the **ADF** position. This is the normal mode of operation, and the main transceiver is connected to the VHF antenna for commu-

nication. At the same time, the auxiliary receiver is connected to the ADF antenna for automatic direction finding.

When the main receiver is at **ADF** position, the auxiliary transceiver is at **TR2 (COM2)**. In this alternate mode of operation, the main receiver is connected to the ADF antenna for automatic direction finding, and the auxiliary transceiver operates from the VHF antenna for voice transmission.

When the main receiver is at **VOR (NAV1)** position, the auxiliary transceiver is at **TR1 (COM1)**. In this mode of operation, the main receiver is connected to the VOR antenna for omni-directional radio range navigation, and the auxiliary transceiver operates from the VHF antenna for voice transmission.

When the function of the two transceivers is changed, the channel selectors [2-3, fig. 5-8] must be changed to provide the correct operating frequency for the individual radios.

Important

■ The radio function selector switch is also the main avionics power switch on the X-15A-2 SE addon. Turning the switch to **OFF** will turn the avionics off. The radios, ADF and VOR course indicators, the basic autopilot, and the simulator's GPS unit won't work if the avionics is turned off.

Volume Control Knobs

There are two volume control knobs [6-7, fig. 5-8] on the radio control panel, marked "MAIN" and "AUX". When either of these rotary volume controls is rotated in the direction indicated by the arrow (clockwise), the volume of the respective equipment to the pilot's headset is increased. Counterclockwise turning of either volume will diminish the volume of the equipment being adjusted.

Note: The volume control knobs in the virtual cockpit simply turn their respective radio channel audio on or off. Turn either volume control knob clockwise to turn the audio on. Turn either volume control knob counterclockwise to turn the audio off. The volume

control knobs can be actuated with a single mouse click.

Channel Selector Knobs

There are two rotary channel selector knobs [2-3, fig. 5-8] on the radio control panel used in selecting the desired channel frequency of the equipment in use. The main transceiver channel selector control provides selection of channels within the frequency range of the main VHF transmitter-receiver. A similar channel control selector enables the pilot to select channels on the auxiliary transceiver.

Note: The radio frequency units can be changed by left or right clicking the channel selector knob. The radio frequency decimals can be changed by turning the mouse wheel up or down while pointing the channel selector knob. Continuous rotation is possible by left or right clicking with the mouse and leaving the mouse button depressed until the knob is set to the desired position.

Channel Indicators

There is a channel indicator window [4-5, fig. 5-8] to the right of each channel selector knob. The upper window, marked "MAIN", shows the channel (frequency) that has been selected for the main VHF transceiver. A similar window, marked "AUX", to the right of the auxiliary receiver channel selector knob, displays the channel selected for the auxiliary receiver.

Microphone Buttons (PTT Switches - ATC Toggle)

The microphone buttons (push-to-talk red switches) are located on the black handles of the center stick [8, fig. 4-1] and of the right console stick [27, figure 4-1]. Clicking either microphone button in the virtual cockpit will open the ATC window in the simulator.

Radio-Magnetic Indicator

An optional radio-magnetic indicator is provided on the center panel. To show/hide the

RMI, click the glass in front of the dynamic pressure gauge [10, fig. 5-1], above the attitude indicator [9, fig. 5-1].

The radio-magnetic indicator incorporates one movable compass card, two direction pointers, and one fixed index card.

Note: The index card can be rotated in the simulator by left or right-clicking the synchronizer knob. The card was fixed in the original X-15.

The compass card displays azimuth reference with respect to the surface of the earth. The compass card is synchronized with the stable platform of the flight data system. A push-to-set synchronizer knob at the lower left side of the indicator permits adjustment of the compass card to read airplane azimuth displacement either from magnetic north or from the high range centerline. The knob may be turned (with the mouse wheel) to accurately synchronize the card with the stable platform during initial operation of the system.

Note: Turning the synchronizer knob will also affect the the sphere in the attitude indicator [9, fig. 5-1].

Note: You can use the magnetic heading information displayed in the top left section of the simulator's main window to synchronize

the compass card in the RMI and the sphere in the attitude indicator [9, fig. 5-1]. Press **"SHIFT-Z"** to show/hide the heading information.

The double-barred pointer is synchronized with the antenna of the automatic radio direction finder (ADF) system. It reads displacement between the airplane centerline and a course to the ADF ground station.

The single-barred pointer is synchronized with the VOR antenna. It reads displacement between the airplane centerline and a course to the VOR ground station.

The radio-magnetic indicator is powered by the primary DC bus and the No. 1 primary AC bus.

Make sure the avionics is turned on before using the radio-magnetic indicator (see "Radio Function Selector Switch (Avionics Power Switch)" above).

GPS Receiver

The stock Garmin® 500 GPS receiver that comes with your simulation platform is available from the simulator's top menu bar. Refer to your simulation platform's manual for instructions on how to use the GPS unit. Make sure the avionics is turned on before using the GPS (see "Radio Function Selector Switch (Avionics Power Switch)" above).

Operation of VHF Communication and ADF System

Normal Operation. The normal operating procedure is as follows:

1. Function selector switch - **TR1** (COM1 on main transmitter-receiver). The auxiliary receiver will be at ADF.

2. Main channel selector knob - **Select desired channel**.

3. Auxiliary channel selector knob - **Select desired channel**.

4. "MAIN" and "AUX" volume controls - As

desired (turn left for **OFF**, turn right for **ON**).

Alternate Operation. To use the auxiliary transceiver, proceed as follows:

1. Function selector switch - **TR2** (COM2 on auxiliary transmitter-receiver). The main receiver selection will be at ADF.

2. Main channel selector knob - **Select desired channel**.

3. Auxiliary channel selector knob - **Select desired channel**.

4. "MAIN" and "AUX" volume controls - As desired (turn left for **OFF**, turn right for **ON**).

RADAR BEACON SYSTEM

Note: The X-15 radar beacon system is not supported in this software version.

On the real aircraft, radar beacon system ED-1-519 automatically receives and returns radio-frequency signals from a ground tracking station to enable ground radar crews to track the flight of the X-15 airplane.

The receiver and the transmitter of the radio beacon are tuned independently to a pre-selected frequency within the 2700-to-2900-megacycle range. The radar beacon is designed to operate dependably from a minimum range of 1200 yards to a line-of-sight range of at least 150 miles when operated in conjunction with a ground radar set SCR-784, or equivalent.

The antenna for the radar beacon [23, fig. 3-1] is on the bottom of the fuselage, just forward of the second ventral antenna. The radar beacon receiver and transmitter use the same antenna.

The radar beacon system is powered by the No. 1 primary AC bus through a switch in the cockpit.

Radar Beacon Switch

The radar beacon switch [14, fig. 5-3], on the center pedestal, controls No. 1 primary AC bus power to the radar beacon system. The witch has two maintained positions, ON and OFF.

INTERCOMMUNICATION SYSTEM

Note: The B-52/X-15 intercom is not supported in this software version.

On the real aircraft, the X-15 pilot's microphone button and headset can be connected to the carrier airplane intercommunication system through a switch in the cockpit. Depending on carrier airplane intercommunication system switch settings, the X-15 pilot can communicate directly with the carrier airplane or transmit and receive by means of the carrier airplane command radio.

Intercommunication Switch

The two-position intercommunication switch [2, figure 5-4], on the left console and labeled "INTERCOM", controls the function of the X-15 pilot's microphone buttons and headset.

With the switch at **ON**, the X-15 pilot can communicate with the carrier airplane through the carrier airplane intercommunication system or transmit and receive command radio signals through the carrier air-

plane command radio, depending on the position of the carrier airplane intercommunication system function selected. With the switch at **OFF**, the X-15 pilot's microphone buttons and headset are connected to the X-15 radio.

Note: If the intercommunication switch is at **ON** at time of launch, the pilot will not be able to use the X-15 radio. This will be readily noticeable by the lack of static background noises or side-tone signals in the headset.

COCKPIT LIGHTING SYSTEM

The cockpit is lighted by two floodlights [4, fig. 4-3] attached to the canopy and located so that the light is directed forward and down, covering the entire cockpit controls and gauges. These adjustable lights are shielded to eliminate direct glare to the pilot. A switch on the instrument panel right wing controls the lighting system. The lighting system is powered by the primary DC bus.

Cockpit Lighting Switch

A two-position switch [39, figure 5-1], on the instrument panel right wing, controls the cockpit lighting system. The switch has ON and OFF positions and is labeled "COCKPIT LIGHTS". The switch is powered by the

primary DC bus.

Note: When the aircraft is powered, flipping this switch to **ON** will turn on the two cockpit floodlights that are attached to the inside of the canopy, illuminating the virtual cockpit and the instrument panels. The cockpit will stay illuminated when in the invisible canopy mode.

PILOT'S OXYGEN SYSTEM

The pilot's oxygen system is a high-pressure (3000 psi), gaseous-type system, completely contained within the ejection seat and pilot's back pan.

Two 96-cubic-inch, lightweight cylinders are mounted on the bottom of the seat [4, fig. 4-2]. The charging valve for both cylinders is about 6 inches above the seat bucket on the back rest.

This system will supply 100 percent oxygen to the helmet for approximately 45 minutes at a pressure of 1½ inches of water above the pilot's suit pressure, which varies with altitude. A reducer valve, incorporated in the high-pressure line, reduces the cylinder pressure from 3000 psi to 70 to 90 psi at the pilot's personal-lead quick-disconnect [12, fig. 4-2]. The oxygen then flows into the back pan through a regulator and into the face mask.

The system includes a warning system to indicate when breathing oxygen pressure is approaching the minimum for which the

pressure suit is designed to permit normal breathing. No dilution is required in this system.

Breathing oxygen is supplied by the carrier airplane from take-off until just before launch, at which time the pilot selects the X-15 airplane oxygen supply. The oxygen supply is also utilized to pressurize the pilot's pressure suit in case the nitrogen ventilation and pressurization supply should fail.

Warning

- The oxygen supply to the pressure suit helmet must be on and the helmet visor must be down before the cockpit is pressurized with nitrogen.

If ejection is necessary, the complete oxygen system is retained with the seat.

Note: The canopy and the seat cannot be ejected in this software version.

Immediately before ejection, the green ball on the upper right side (chest area) of the pressure suit should be pulled to activate the emergency oxygen system and maintain suit pressurization after separation from the seat. When the green ball is pulled, the oxygen in the back pan flows through a pressure reducer, on through an oxygen regulator and a pressure suit regulator, to the pressure suit and helmet. The emergency oxygen supply, contained in the back pan, has a capacity of about 100 cubic inches at a cylinder pressure of 1800 psi and for a duration of about 20 minutes.

Note: Pilot's oxygen pressure can be monitored on the system monitor panel.

During the time interval between seat separation from the airplane and pilot separation from the seat, the breathing oxygen is drawn from the normal system oxygen bottles attached to the seat. This is made possible by a valve in the emergency system, which is kept closed by a pressure differential until the pilot separates from the seat.

Pilot's Oxygen System Selector and Pressure Gauge

A three-position oxygen system selector, mounted on the forward end of the left side panel of the seat [18, fig. 4-2], allows pilot selection of two separate oxygen systems. The three positions, labeled "B-52", "OFF" and "X-15," depend on the phase of flight as to which system is selected.

The control head is a round, tubular aluminum section with the oxygen pressure gauge mounted in the center. The selector is positioned by turning it from the middle **OFF** position, either right or left, to select the desired system (**X-15** or **B-52**).

The gauge range is from 0 to 3000 psi. Permanent markings are on the range scale. There is a red radial at 200. a yellow arc from 200 to 1000, and a green arc from 1000 to 3000. If the breathing oxygen is depleted to the point where the gage pointer is at 200, the green ball on the pilot's pressure suit must be pulled to actuate the emergency breathing oxygen supply.

Pilot's Oxygen-Low Caution Light

The pilot's oxygen-low caution light [6, fig. 5-1] is on the instrument panel, directly above the airspeed/Mach indicator [5, fig. 5-1]. The placard-type amber light is powered by the primary DC bus and when illuminated reads "PILOTS 0_2 LOW". It comes on when breathing oxygen pressure downstream of the reducer valve drops to about 60 psi. When the light comes on, the pilot is alerted to the possibil-

ity of encountering oxygen supply pressure sufficiently low to ultimately result in breathing difficulty.

NORMAL OPERATION OF PILOT'S OXYGEN SYSTEM

For operation of the oxygen system, proceed as follows:

1. Upon entry into cockpit, move oxygen system selector to **B-52**.

2. Before launch, move oxygen system selector to **X-15**.

EMERGENCY OPERATION OF PILOT'S OXYGEN SYSTEM

If the pilot's oxygen-low caution light [6, fig. 5-1] comes on after the X-15 oxygen system has been selected, be prepared to actuate the emergency oxygen supply as soon as you are aware of breathing difficulty. The time between illumination of the light and when breathing difficulty is first encountered is dependent on several factors, including breathing rate, pilot size, and cabin pressure altitude.

Note: This is done automatically in the simulator.

PILOT'S PRESSURE SUIT SYSTEM

The pilot's A/P22S-2 full-pressure suit is ventilated and pressurized by either the X-15 or the augmented cooling system liquid nitrogen supply.

The liquid nitrogen flows through a heat exchanger and flow restrictor, where it is converted to gaseous nitrogen, then through a check valve, an electrical heater, and then to the vent suit flow control valve. From the vent suit flow control valve, the gaseous nitrogen is routed through a flexible disconnect hose and coupling to the pressure suit.

After launch, ventilation of the pressure suit is maintained by the nitrogen system of the X

-15 airplane. Suit pressure is maintained at 1/10 psi above cockpit pressure at all altitudes above 35,000 feet. If cockpit pressure should fall, the nitrogen supply will pressurize the suit to maintain the 35,000-foot environment. The same routing lines and controls are used whether the nitrogen comes from the carrier airplane or the X-15.

The desired volume of flow can be controlled from the cockpit. Temperature of the gaseous flow to the pressure suit may be controlled from approximately 50° F to 90° F by the vent suit gaseous heater. The heater is of the electric-tubular type and is controlled from the cockpit. Pressure and ventilation to the pressure suit are maintained automatically up to the vent suit flow control valve, when the air conditioning and pressurization system is in operation, by either the carrier airplane or the X-15 nitrogen system.

The pressure suit is equipped with a pressure regulator that is used for suit ventilation, and an anti-blackout pressure regulator that operates from the breathing oxygen supply. In addition to these provisions, the suit back pan also contains a demand-type oxygen regulator for normal and emergency use and a stored supply of oxygen to be used during emergency ejection.

An integrated parachute harness and restraint assembly also forms a part of the pressure suit.

Pressure Suit Ventilation Knob

A knob [5, fig. 5-4], on the left console, controls the flow of gaseous nitrogen to the pressure suit. This knob, marked "PRESS. SUIT VENT", has an arrow to indicate the direction the knob should be turned (counterclockwise) to increase the volume and flow of the nitrogen to the suit.

The knob has direct mechanical linkage to the flow control valve. Nitrogen flow is restricted to 7 cubic feet per meter by a stop on the knob. This is to prevent excess nitrogen flow which could override the capabilities of the vent suit heater in addition to causing suit over-pressurization. The 7 cfm provides sufficient ventilating gas flow for normal conditions. When initiating suit ventilation, the knob should be opened about one turn and then the vent suit heater switch [6, fig. 5-4] should be moved to either **HIGH** or **LOW**, as required. If additional ventilation is required, the knob can be opened further.

Vent Suit Heater Switch

The vent suit heater switch [6, fig. 5-4], on the left console, is a three-position switch. The switch is powered by the primary DC bus. The heater is powered by the primary AC busses.

With the switch in the **HIGH** position, the gaseous nitrogen to the vent suit is heated to a temperature of approximately 75° F to approximately 90° F and is maintained within that range by a thermoswitch.

With the switch in the **LOW** position, another thermoswitch maintains a temperature of approximately 55° F to approximately 70° F.

With the switch in the **OFF** position, the heater is inoperative, and the temperature of the gaseous nitrogen is that of the system temperature.

Caution

- When the augmented cooling system liquid nitrogen supply is being used during captive flight, the vent suit heater switch should be at **HIGH** or **LOW**, as necessary, to prevent liquid nitrogen from entering the area between the inner and outer windshield panels and consequently obscuring vision.

- When either the augmented cooling system or the X-15 liquid nitrogen system is supplying gaseous nitrogen to the pilot's ventilated suit, the vent suit heater switch should be at **HIGH** or **LOW**, as necessary, to ensure that the liquid nitrogen is converted to gaseous nitrogen. When there is no nitrogen flow (augmented cooling and X-15 liquid nitrogen systems turned off), the heater switch should be turned off to prevent damaging the heaters and equipment adjacent to the heaters.

Face Mask Heater Switch

Primary DC bus power for the helmet visor heat elements is controlled by a four-position switch [3, fig. 5-4], on the left console. The switch is labeled "FACE MASK HTR".

The face mask heater is energized when the switch is moved from **OFF**. Heat is increased as the switch is moved from the **LO** to the **MED** and **HI** positions.

MISCELLANEOUS EQUIPMENT

Aircraft Clock and Stopwatch

A typical A-13A aircraft clock and stopwatch [46, fig. 5-1] is installed on the main panel. The A-13A is a small mechanical clock which

runs for about a week on a single winding. The two large pointers (hands) are the clock's hour and minute indicators. The two small pointers are the stopwatch's minute and second indicators.

On the real aircraft, the large button in the bottom left corner is used to wind and set the clock. In the simulator, this button is used to set the clock only. Hours are set by left or right-clicking the button with the mouse. Minutes are set with the mouse wheel.

Known Issue (FSX)

- Setting the local time with the aircraft clock sometimes produces unexpected results in FSX, including freezing the screen while the simulator is updating the environment and traffic. If you experience such an issue on your simulation platform, we recommend changing the local time on the "SELECT TIME AND SEASON" page in the simulator (available from the "World" menu item in the top menu bar) instead.

To use the stopwatch, press (click) the small button in the top right corner to **start**. Press the button again to **stop**. Press a third time to **reset** the stopwatch to zero.

Skylight Hatch

The X-15A-2 has a skylight hatch on top of the instrument compartment that gives the instrumentation equipment access to the outside environment. The X-15A-2 skylight hatch consists of two hydraulically-activated 20 by 8½-inch doors.

The instrument compartment on the X-15A-2 addon carries an ultraviolet "star tracker" and an ultraviolet horizon scanner that allow for stellar photography experiments. A switch [19, fig. 5-3] on the center pedestal is used to open or close the hatch. An amber caution light [73. fig. 5-1], on the instrument panel, when illuminated, indicates that the hatch is open. For more information, refer to "Instrumentation System Controls and Indicators".

Note: The skylight hatch is hydraulically activated. It needs hydraulic power to open or close.

Ablator Coating

Hypersonic flight generates tremendous amount of heat and a special ablative coating is used to protect the exterior of the X-15A-2 aircraft during special missions. It consisted of the basic Martin MA-25S pink ablator (that was used on the space shuttle external tank) sealed with the Dow Corning DC90-090 white protective wear layer.

An "eyelid" was designed to protect the left canopy window from being smeared with ablator residue during high speed flight.

Eyelid

An external "eyelid" [37, fig. 3-1] is provided on selected X-15A-2 aircraft to protect the left elliptical canopy window from being smeared with ablator residue during high speed flight. The eyelid is closed before the acceleration phase and re-opened before landing. A special handle [6, fig. 4-3], in the cockpit, is used to open or close the eyelid.

Note: If you forgot to close the eyelid before a high speed flight, you can **right-click the eyelid handle** to clean ablator splatters from the windows.

Eyelid Handle

The handle [6, fig. 4-3], below the left window on the left side of the canopy (on selected X-15A-2 aircraft), is mechanically-linked to the external eyelid on the left elliptical canopy window. Pushing the handle to its forward position opens the external eyelid. Pulling the handle to its aft position closes the external eyelid.

Note: If you forgot to close the eyelid before a high speed flight, you can **right-click the eyelid handle** to clean ablator splatters from the windows.

EXTERNAL TANKS AND X-15A-2 SYSTEMS

The "advanced" X-15A-2 was rolled out in early 1964. It was especially designed to attain hypersonic velocities in the range of 8000 feet per second at an altitude of about 100,000 feet.

The obvious modifications are the addition of a 29-inch fuselage extension between the internal liquid oxygen and ammonia tanks and two large external propellant tanks which can be jettisoned and reused. The added propellant permits a longer engine run which results in added velocity.

This section contains only those additions to, or deviations from, the preceding sections of this manual that are peculiar to the design and operation of the X-15A-2 airplane. Where information in this section differs from that in the preceding sections, the descriptive text and steps of procedures herein shall take precedence when the X-15A-2 airplane is being operated.

Information not contained in this section is the same for X-15 and X-15A-2 airplanes.

X-15A-2 ENGINE

Engine Compartment Purging System

Pilot operation of this system is the same as on X-15 airplanes. However, depending on flight configuration, helium for purging of the engine compartment may be obtained from either the 0.491-cubic-foot bottle (located in the 29-inch fuselage extension) or the 2.4 cubic-foot bottle [11, fig. 3-2] (located on top of the engine shroud, just aft of the upper vertical tail).

Note: Helium for purging of the engine compartment (or extinguishing an engine fire) is obtained from the 0.491-cubic-foot bottle (located in the 29-inch fuselage extension)

on the X-15A-2 SE addon. Helium pressure in the 0.491-cubic-foot bottle can be monitored on the auxiliary pneumatic and control pressure gauge [21, fig. 5-3] on the center pedestal.

Turbopump Propellant (H_2O_2) System

In addition to the 74.4-gallon spherical supply tank, hydrogen peroxide monopropellant (90% H_2O_2) is stored in four 10.85-gallon spherical supply tanks, two on each side of the fuselage, adjacent to the engine compartment, in the side fairings. Monopropellant from these tanks is transferred into the 74.4-gallon tank, which in turn supplies monopropellant to the engine turbopump.

Vent, Pressurization, and Jettison Lever

To pressurize or jettison the propellant in the external tanks, the fuel selector switch [8, fig. 5-6] must be at **EXTERNAL**, when the desired function is selected with the vent, pressurization, and jettison lever [11, fig. 5-4]. The external tanks are vented, regardless of the position of the fuel selector switch, when the vent, pressurization, and jettison lever is moved to **VENT**.

X-15A-2 DROP TANK SYSTEM

A jettisonable external tank may be mounted on the lower left and lower right side fairings.

The right-hand external tank has a usable capacity of 1053 gallons (6070 pounds) of liquid anhydrous ammonia. The left-hand external tank has a usable capacity of 770 gallons (7590 pounds) of liquid oxygen. The left-hand tank also contains three small cylindrical helium tanks for propellant pressurization and airplane pneumatic control.

Each external tank has a self-contained jettison-recovery system. The parachute recovery portion of the system is automatically activated when the tanks leave the airplane.

Servicing of the external tanks is accom-

plished, after the tanks are installed on the airplane, through the airplane internal propellant system. In flight, the liquid oxygen and ammonia are transferred under helium pressure to their respective internal tanks. Indication of propellant flow from the external tanks is displayed to the pilot on a gauge in the cockpit.

When the external tanks are empty, the system shifts automatically to the internal tanks. Empty, full or partially-full external tanks can be released automatically or manually, as selected by the pilot. Lights in the cockpit indicate when the external tanks are ready to be jettisoned.

External Tanks Option Switch

A fictitious external tanks option switch [26, fig. 5-3], on the service panel, is provided for choosing whether or not the X-15A-2 external drop tanks are installed. The external tanks provide an additional 1053 gallons of anhydrous ammonia and 770 gallons of liquid oxygen which corresponds approximately to an additional 60 seconds of engine burn time.

Make sure this switch is set to **INSTALLED** for true X-15A-2 operation (external tanks on).

The external tanks option switch cannot be set if the propellant tanks are pressurized (vent, pressurize, and jettison lever [11, fig. 5-4] not at **VENT**).

Note: External tanks are emptied when the

external tanks option switch is moved to **NOT INSTALLED**, then back to **INSTALLED**. Tanks will need to be refilled (refer to "Express Fill Button").

Fuel Selector Switch

The two-position "FUEL SELECTOR" switch [8, fig. 5-6], on the drop tanks control panel (on the left console), is powered by the primary DC bus.

With the switch at **EXTERNAL** (propellant system pressurized), the transfer system is activated and the propellant is transferred from the external tanks to the internal tanks. At the end of a preset time period, an intervalometer times out, deactivating the transfer system, and indicator lights in the cockpit come on, indicating that the tanks are ready to be released. The propellant feed system automatically shifts to internal tank feed, and it is not necessary to reposition the "FUEL SELECTOR" switch.

When the switch is placed at **INTERNAL** (propellant system pressurized), the transfer system is deactivated and propellant feeds from internal tanks only, regardless of propellant remaining in the external tanks.

Note: The "FUEL SELECT" switch must be in the **EXTERNAL** position whenever external tanks are installed.

Note: To pressurize or jettison the propellant in the external tanks, the fuel selector switch

must be at **EXTERNAL**, when the desired function is selected with the vent, pressurization, and jettison lever [11, fig. 5-4]. The external tanks are vented, regardless of the position of the fuel selector switch, when the vent, pressurization, and jettison lever is moved to **VENT**.

External Tanks Jettison Circuit Breakers

These two-position switches [1-2, fig. 5-6], labeled "TANK JETT C/B", on the drop tanks control panel [18, fig. 4-1] (on the left console), apply or remove battery bus power to the external tank release circuits and controls.

Important

- Both circuit breakers (switches) must be moved to **ON** (forward position) prior to the release of the external tanks.

- The external tanks will not jettison if these switches are at **OFF** (aft position).

External Tanks Jettison Safe-Arm Switch

This two-position, guarded switch [4, fig. 5-6], on the drop tanks control panel (on the left console), is powered by the battery bus and controls arming of the external tank release circuits.

With the switch in the guarded **SAFE** position, the release circuits are open, and the release system is inoperative. Raising (clicking) the guard and placing the switch at **ARM** arms the release system for selection of the desired mode of external tank release.

External Tanks Jettison Auto-Manual Switch

This two-position switch [3, fig. 5-6], on the drop tanks control panel [18, fig. 4-1] (on the left console), is powered by the primary DC bus and controls selection of the automatic or manual mode of tank release.

Placing the switch at **AUTO** (fuel selector switch [8, fig. 5-6] at **EXTERNAL** and external tanks jettison safe-arm switch [4, fig. 5-6] at **ARM**) activates the automatic mode of external tank release system. When the intervalometer times out, the propellant transfer system is deactivated, the external tanks jettison ready indicator lights come on, and the external tanks are automatically released.

Placing the switch at **MANUAL** (with the external tanks jettison safe-arm switch at **ARM**) activates the manual mode of the external tank release system. When the intervalometer times out, the propellant transfer system is deactivated, and the external tanks jettison ready indicator lights come on. To release the tanks, the pilot must press the external tanks jettison button (see below).

External Tanks Jettison Full Button

This red button [5, fig. 5-6], on the drop tanks control panel (on the left console), is powered by the battery bus.

Momentarily depressing this button (with the external tanks jettison safe-arm switch [4, fig. 5-6] at **ARM**) releases the external tanks. This button must be used to release the full tanks, for successful tank separation.

Caution

- Use the external tanks jettison full button only to jettison a full tank, as serious damage to the tanks and airplane will result if other jettison methods are used.

External Tanks Jettison Partially Full Button

This black button [6, fig. 5-6], on the drop tanks control panel (on the left console), is powered by the battery bus.

Momentarily depressing this button (with the external tanks jettison safe-arm switch [4, fig. 5-6] at **ARM**) releases the external tanks. This button must be used to release the partially full tanks, for successful tank separation.

Caution

- Use the external tanks jettison partially full button only to jettison a partially full tank, as serious damage to the tanks and airplane will result if other jettison methods are used.

External Tanks Jettison Empty Button

This gray button [7, fig. 5-6], on the drop tanks control panel (on the left console), is powered by the battery bus.

Momentarily depressing this button (with the external tanks jettison safe-arm switch [4, fig. 5-6] at **ARM**) releases the external tanks. This button must be used to release the empty tanks, for successful tank separation.

Caution

- Use the external tanks jettison empty button only to jettison an empty tank, as serious damage to the tanks and airplane will result if other jettison methods are used.

Fuel Flow Indicator

An indication of flow of liquid oxygen and ammonia from the external tanks to their respective internal tanks is displayed in the cockpit on a dual-reading gauge [4, fig. 5-1], on the instrument panel. The gauge is pow-

ered by the primary DC bus.

Two pointers travel over separate arcs of calibration which have 0%, 50%, and 100% markings. The left calibration arc and pointer are for the left external tank (liquid oxygen), and the right calibration arc and pointer are for the right external tank (ammonia). During initial pressurization or jettison, the gauges should read approximately 50%. Both pointers should indicate 100% when the engine thrust is at 100%.

External Tanks Jettison Ready Indicator Lights

Two amber "EXT. TANKS JETT READY" indicator lights [4, fig. 5-1], on the instrument panel, are powered by the primary DC bus.

The left light is placarded "LOX TANK" and the right light is placarded "NH$_3$ TANK." These lights, when on, indicate that the external tanks are ready to be released. The lights come on when the intervalometer times out and the liquid oxygen transfer valve closes, and go out when their respective tanks are released.

Note: The press-to-test lights in the cockpit can be tested by pressing (left-clicking with the mouse) the light housing. Left-clicking with the mouse a second time will return the light to its normal operating state.

X-15A-2 PROPELLANT SUPPLY SYSTEM

Liquid Hydrogen Propellant System

The real airplane has provisions for carrying liquid hydrogen (LH$_2$).

Note: Liquid hydrogen is not used on the X-15A-2 addon.

Engine and Propellant System Control Helium System

Helium to pressurize the turbopump hydrogen peroxide supply tank and to supply pneumatic pressure for engine and propellant control is contained in three spherical tanks pressurized to 3600 psi. A 2.0-cubic foot bottle is in the nose section of the left external tank, and 3.54-cubic-foot and 0.491-cubic-foot bottles are in the 29-inch fuselage extension area.

Initial helium pressure is supplied by the 3.54-cubic-foot bottle; however, when engine chamber pressure reaches approximately 150 psi (igniter idle phase), the 3.54-cubic-foot bottle is disconnected from the system, and pressure is supplied by the 2.0-cubic foot bottle in the external tank. When the external tanks are released, the 3.54-cubic-foot bottle is reconnected to the system and supplies the required helium pressure.

The 0.491-cubic-foot bottle provides engine compartment purge gas or provides an auxiliary gas source when the auxiliary liquid hydrogen system is attached.

Propellant Pressurization Helium System

In addition to the helium supply contained in the airplane, two 3.3-cubic-foot bottles are in the nose section of the left external tank. These bottles are pressurized to 3600 psi and are manifolded into the helium propellant supply system to the two propellant system regulators.

With the vent, pressurization, and jettison lever [11, fig. 5-4] at either **PRESSURIZE** or **JETTISON** and the fuel selector switch [8, fig. 5-6] at **EXTERNAL**, helium pressure flows from the two 3.3-cubic-foot bottles, through

the regulators to the liquid oxygen and ammonia external tanks. Pressure builds up in the external tanks, forcing the propellants to flow through the transfer system to the respective internal tanks. The regulators sense the resultant pressure build-up in the internal tanks and regulate the helium flow as required to maintain a nominal 48 psi pressure at the regulator discharge port. Helium pressure is diverted from the internal tanks and directed to the external tanks by helium solenoid valves.

When the fuel selector switch is placed at **INTERNAL**, the propellant transfer system is deactivated at external tanks empty, or the external tanks are released full, these solenoid valves are de-energized, and the helium pressure is directed to the internal tanks without a noticeable loss in gas flow rate.

Liquid Hydrogen Pressurization Helium Supply

On the real aircraft, helium for pressurization of the liquid hydrogen system is supplied by a 2.4-cubic-foot bottle [11, fig. 3-2] located on top of the engine shroud, just aft of the upper vertical tail. This gas source also provides engine compartment purge when the LH_2 is attached.

Note: Liquid hydrogen is not used in the X-15A-2 addon.

Auxiliary Pneumatic and Control Pressure Gauge

Helium pressure contained in the 0.491-cubic-foot bottle is displayed on the "AUX PNEU & CONT." gauge [21, fig. 5-3], on the center pedestal. The gauge is calibrated in 100 psi increments from 0 to 4000 psi. The gauge is powered by the primary DC bus.

H_2O_2 Source Pressure Gauge

Helium pressure contained in the airplane 3.54-cubic foot bottle and the 2.0-cubic-foot bottle in the left external tank is displayed on a dual-reading gauge [57, fig. 5-1], on the instrument panel. Two pointers, one labeled

"I" for the 3.4-cubic-foot bottle and one labeled "E" for the 2.0-cubic-foot bottle, travel over a common arc of calibrations. The arc is calibrated in 100 psi increments from 0 to 4000 psi. The gauge is powered by the 26-volt AC bus.

Propellant Source Pressure Gauge

Helium pressure contained in the airplane 7.1-cubic foot bottle and the two 3.3-cubic-foot bottles in the left external tank is displayed on a dual reading gauge [69, fig. 5-1], on the instrument panel. Two pointers, one labeled "I" for the 7.1-cubic-foot bottle and one labeled "E" for the two 3.3-cubic-foot bottles, travel over a common arc of calibrations. The arc is calibrated in 100 psi increments from 0 to 4000 psi. The gauge is powered by the 26-volt AC bus.

SOLID ROCKET BOOSTER SYSTEM (X-15AD-4)

This addon includes three variations of a fictitious delta wing X-15AD-4 aircraft with rocket engine nozzle extensions and solid rocket boosters, based on different proposed configurations for future X-15 airplanes.

Note: Make sure the parking brake is applied ("**CTRL+.**") before starting the igniter-idle phase with this aircraft. The igniter-idle phase is in reality the jet engine starting phase that may generate enough thrust to move a small aircraft like the X-15 on the runway if the parking brake is not applied (on some platforms). This is due to the immense power of the three engines combined.

(**Did you know?** The XLR-99 engine's second-stage igniter phase by itself produced 1500 pounds of thrust on the real aircraft.)

Solid Rocket Boosters

One Thiokol "Castor 1", 45,000-pound solid rocket booster [5, fig. 3-3] may be mounted on the lower left and lower right side fairings on the X-15AD-4 airplane.

On the proposed aircraft, the rocket boosters would have allowed for a significant increase in altitude, up to 520,000 feet at a maximum velocity of 8700 feet per second. They were not provided to allow for an increase in speed.

Note: Maximum speed and altitude depends on limitations in the simulator.

Solid Rocket Booster Option Switch

A fictitious solid rocket booster option switch [26, fig. 5-3], on the service panel, is provided for choosing whether or not the X-15AD-4 solid rocket boosters are installed.

Make sure this switch is set to **INSTALLED** if you want to fly the X-15AD-4 with the solid rocket boosters installed.

Note: Rocket boosters are emptied when the solid rocket booster option switch is moved to **NOT INSTALLED**, then back to **INSTALLED**. Boosters will need to be refueled (refer to "Express Fill Button").

Solid Rocket Booster Operation

The solid rocket boosters are ignited as soon as the main XLR-99 engine is fired (when moving the throttle [12, fig. 5-4] inboard to **START 50%** at the end of the ignition sequence). They will burn for approximately 50 seconds after which they need to be released either manually or automatically.

Some modern solid fuel rocket boosters can be extinguished after they are fired. We know however that this is something the type of boosters installed on the AD-4 could not do. But we needed to provide a way to shut them off to go around the simulator's bad habit of starting the engines when positioning the aircraft in mid-air with the map or with the slew commands. This is why the boosters will shut down if the throttle is moved outboard to **OFF**.

To re-ignite the boosters after they were shut down, you will need to move move the igniter-idle switch [53, fig. 5-1] to **OFF**, then back to **IGNITER**. When the throttle is moved inboard to **START 50%**, the three engines will fire, including the rocket boosters.

Rocket Booster Emergency Release

Should it become necessary to release the rocket boosters in an emergency before a normal engine burnout, switches are provided on the solid rocket boosters control panel [18, fig. 4-1] on the left console to allow the pilot to manually release the boosters. The solid rocket boosters on the X-15AD-4 will shut off automatically before they are jettisoned.

Rocket Boosters Jettison Circuit Breakers

These two-position switches [1-2, fig. 5-6], labeled "BOOSTER JETT C/B", on the solid rocket boosters control panel [18, fig. 4-1] (on the left console), apply or remove battery bus power to the rocket booster release circuits and controls.

Important

- Both circuit breakers (switches) must be moved to **ON** (forward position) prior to the release of the rocket boosters.

- The rocket boosters will not jettison if these switches are at **OFF** (aft position).

Rocket Booster Jettison Safe-Arm Switch

This two-position, guarded switch [3, fig. 5-7], on the solid rocket boosters control panel [18, fig. 4-1] (on the left console), is powered by the battery bus and controls arming of the rocket booster release circuits.

With the switch in the guarded **SAFE** position, the release circuits are open, and the release system is inoperative. Raising (clicking) the guard and placing the switch at **ARM** arms the rocket booster release system.

Rocket Booster Jettison Auto-Manual Switch

This two-position switch [4, fig. 5-7], on the solid rocket boosters control panel [18, fig. 4-1] (on the left console), is powered by the primary DC bus and controls selection of the automatic or manual mode of booster release.

Placing the switch at **AUTO** (solid rocket booster jettison safe-arm switch [3, fig. 5-7] at **ARM**) activates the automatic mode of the booster release system. When normal engine burnout occurs, the solid rocket boosters are automatically released.

Placing the switch at **MANUAL** (with the solid rocket boosters jettison safe-arm switch at **ARM**) activates the manual mode of the booster release system. To release the tanks, the pilot must press the solid rocket boosters jettison button (see below).

Rocket Boosters Jettison Button

This gray button [5, fig. 5-7], on the solid rocket boosters control panel [18, fig. 4-1] (on the left console), is powered by the battery bus.

Momentarily depressing this button (with the solid rocket booster jettison safe-arm switch [3, fig. 5-7] at **ARM**) releases the solid rocket boosters.

NORMAL PROCEDURES AND CHECK LIST

This section contains the complete normal procedures and check list for the operation of the Xtreme Prototypes X-15A-2 Special Edition v2.0 addon on your simulation platform.

GETTING STARTED

The operation of the X-15A-2 SE addon is very similar to the operation of the real aircraft. For proper operation and enhanced realism, it is suggested that users follow the procedures presented in this section very carefully.

Following each step presented in this section will teach you how to prepare and how to fly your new X-15A-2 SE addon. You may also refer to the quick-start procedures in section 7 to start the engine without going through the complete procedures. However, following each step presented in this section will make your overall experience much more realistic and enjoyable.

The following procedures are inspired or adapted from the original X-15 and X-15A-2 utility flight manuals

TYPICAL X-15 MISSION

In a typical X-15 mission, the rocket airplane is attached under the right wing of a modified B-52 bomber and carried to an altitude of about 45,000 feet. Then, at a scheduled launch time, it is dropped and the pilot fires the airplane's mighty XLR-99 rocket engine to propel the X-15A-2 at several times the speed of sound to new high altitude and speed records.

Note: There seems to be no limit to the maximum altitude to be attained by the X-15A-2 in FSX or Prepar3D® (which was limited to 100,000 feet in FS2004). For example, it is now possible to recreate the highest flight of the X-15 program achieved by X-15-3 on August 22, 1963 (354,200 feet). Unfortunately,

TYPICAL X-15 MISSIONS

Typical high-speed and high-altitude missions of the North American X-15 research aircraft.
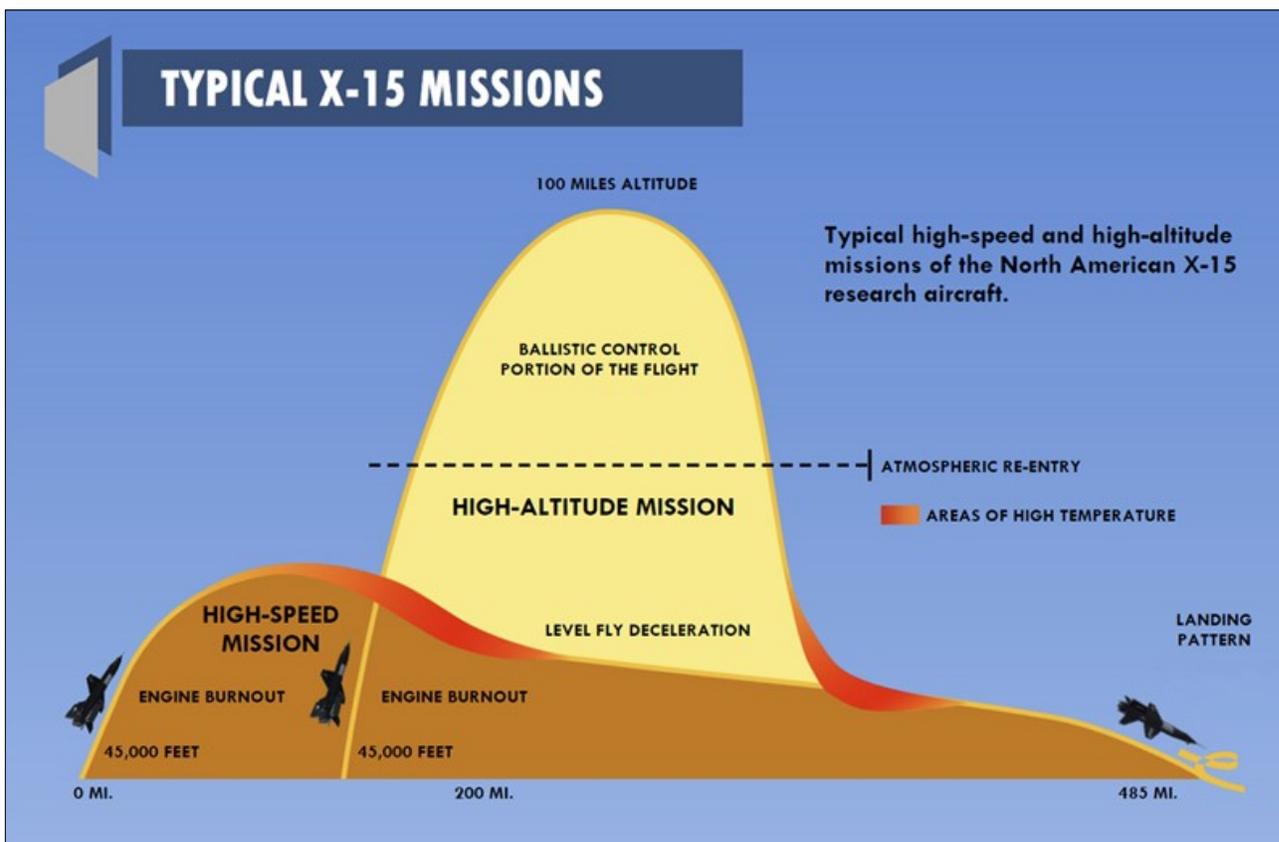
speed is still limited to approximately Mach 4.65 on all current platforms.

Note: The highest altitude attained by the real X-15A-2 rocket plane was 249,000 feet (August 3, 1966).

Several experiments are conducted during the mission to get as much information as possible about high speed and high altitude flight and about the effects of such flight conditions on the aircraft and on the pilot.

If we exclude the climb to the launch altitude (during captive flight), a typical X-15A-2 mission would last for about 10 minutes, of which about 90 seconds (no external tanks) to 150 seconds (external tanks installed) saw the engine burning.

The procedures presented here are for a typical mission only, and do not cover any specific experimentation, except for the (optional) opening and closing of the skylight hatch [16, fig. 3-2] to expose the star tracker system to the exterior environment.

After the airplane propellants are exhausted or

the engine is shut off by the pilot, the X-15 performs reentry into the atmosphere (if on a high altitude mission) and begins a shallow descent before her final glide to a dry lakebed in the high desert of California.

Design Mission Summary

The following is a summary of the real X-15A-2 design mission airspeed-altitude time history:

The X-15A-2 is launched at Mach .82 at 45,000 feet. An immediate engine light is obtained and pull-up to a constant lift coefficient (C) of .65 is executed. This C is maintained until a flight path angle of 36 degrees is obtained, at which time a push-over to zero G is accomplished.

The external tanks are released as soon as practical when empty (Mach 2.1 at 70,000 feet) and the zero-G trajectory is continued on internal propellants to level flight at about 100,000 feet altitude. The airplane is then accelerated at this altitude to burn out at about 8000 fps.

The deceleration is made, maintaining 100,000 feet altitude until C, for maximum UD, is reached (C -25) where descent is made maintaining this C.

About Rocket-Propelled Flight in the Simulator

- At the time of publication, rocket engines were still not supported in either Microsoft® Flight Simulator X or Lockheed Martin® Prepar3D®. Your simulation platform still sees the X-15A-2's XLR-99 engine, and the solid rocket boosters on the X-15AD-4, as jet engines. Rocket-propelled flight is therefore not 100% accurate in the simulator although we tried our best to emulate it as much as we could in the flight model, considering the present limitations. We sincerely hope that all simulation platforms will offer support for rocket engines (and ballistic control) in the near future.

We Know...

The real X-15 could not take off from the ground. So why can the X-15A-2 SE addon take off from the ground?

Simply because it's fun! This is a simulation after all, and many things that are not permitted in the real world can be done in a simulator. Plus, we thought that our users would like to take off from the ground in their new X-15 addon.

This also gives the beginner desktop pilot

plenty of time to learn and perform the required preflight procedures while the aircraft in comfortably sitting on the ground instead of falling like a brick in mid-air.

For purists, it is possible to simulate a high altitude launch by using the slew mode commands to reposition the X-15 airplane without flying in real time. A second option is to change the altitude and speed settings in the map window, available from the "World" menu item on the simulator's top menu bar. You can also load one of the high altitude "launch" saved flights that come with the addon.

For simplicity and to allow for easy ground servicing of the X-15A-2 SE addon while you are still learning about this unique aircraft, the following procedures assume a normal takeoff from the ground.

STARTING YOUR FLIGHT SIMULATION PLATFORM

The X-15A-2 Special Edition v2.0 is an add-on software package that requires Microsoft® Flight Simulator X with Acceleration Expansion Pack (or Flight Simulator Gold fully installed) or Lockheed Martin® Prepar3D® to be installed on your computer. The software is not a stand-alone product and cannot be used without the underlying simulation platform.

Refer to "Minimum System Requirements" for more information.

Starting your Flight Simulation Platform

1. Make sure that your simulation platform and the X-15A-2 SE addon are properly installed on your computer before you proceed (refer to "Software Installation").

2. Make sure your joystick and pedals are properly connected to your computer and have been previously tested with your simulation platform. A joystick is essential to fly the X-15A-2 SE addon. Rudder pedals are optional.

3. Make sure your mouse has a center wheel. A "wheelmouse" is essential to actuate some controls in the virtual cockpit, such as 3-position switches.

4. Start your simulation platform (Microsoft® Flight Simulator X or Lockheed Martin® Prepar3D®).

5. Do not load, create or start a new flight until you are instructed to do so.

Note: The user interface may vary between Microsoft® Flight Simulator X and Lockheed Martin® Prepar3D®. However the commands and settings are essentially the same.

Important

■ **Do not use "CTRL+E" to start the engine** — The simulator's autostart command ("CTRL+E") should not be used to start the X-15A-2 SE engine. For a quick start, use the automatic ignition sequence start button [76, fig. 5-1], located on the main instrument panel instead. This is similar to pressing "CTRL+E" with conventional aircraft. However, the red button initiates all X-15A-2 rocket aircraft systems, including the special three-propellant fuel management system.

■ **All systems are reset when a new X-15A-2 aircraft is loaded** — Correct ignition sequence procedures (including clicking the autostart button) must be performed each time a new X-15A-2 aircraft is loaded in the simulator. This is because the X-15A-2 SE addon uses its own proprietary internal variables in addition the simulator's variables. Unfortunately, due to software limitations, these custom variables are not memorized by the simulator between flights. If the panels appear "frozen" after a new aircraft was loaded while in flight, simply end the current flight and start a new flight with another X-15A-2 aircraft.

SIMULATION PLATFORM INITIAL SETTINGS

Custom Fuel Management System

Your X-15A-2 SE addon uses a custom three-propellant fuel management system.

This system bypasses the simulator's fuel management system and needs some special settings in the simulator to work properly.

If not already done:

1. Under "Aircraft" (or "Vehicle") in the simulator's top menu bar, select **REALISM SETTINGS.**

2. On the "Settings – Realism" page, under "Engines", select the **UNLIMITED FUEL** option.

3. Click **OK** to close the "Settings – Realism" page.

For more details, refer to the recommended settings for your simulation platform.

Visual Effects

The X-15A-2 SE addon uses the simulator's default aircraft lights to display special visual effects. This needs some special settings:

1. Under "Aircraft" (or "Vehicle") in the simulator's top menu bar, select **REALISM SETTINGS.**

2. On the "Settings – Realism" page, under "Instruments and Lights", select the **PILOT CONTROLS AIRCRAFT LIGHT** option.

3. Click **OK** to close the "Settings – Realism" page.

For more details, refer to the recommended settings for your simulation platform.

Other Recommended Settings

These settings will make your flights in the X-15A-2 SE addon more enjoyable:

1) Under "Aircraft" (or "Vehicle") in the simulator's top menu bar, select **REALISM SETTINGS.**

2) On the "Settings – Realism" page, set the followings:

    a) All "Flight model" settings – **EASY** (cursor to the left).

    b) Enable gyro drift – **UNSELECTED.**

    c) Display indicated airspeed – **SELECTED.**

    d) Ignore crashes and damage – **SELECTED.**

    e) G-effects – **UNSELECTED.**

3) Click **OK** to close the "Settings – Realism" page.

For more details, refer to the recommended settings for your simulation platform in section 2.

ADJUSTING THE SOUND VOLUME

The XLR-99 rocket engine, which according to X-15 pilot Milt Thompson "*...had a very distinct banshee-type sound that was instantly recognizable... from the rumbling of the ignition sequence through the main chamber light off to the peculiar hog calling like noise of the shutdown*"1, will produce a great deal of noise and vibrations during normal operation.

1: Thompson, Milton O.; "At the Edge of Space: The X-15 Flight Program"; Smithsonian Books (1992).

The XLR-99 engine has no rotating parts, so

the sound is very different from one would expect from a jet aircraft engine. Low frequency noise, rumble and acoustic shock waves were added to the basic sound effect for more realism.

For this reason, you may want to adjust the volume levels in the "Settings – Sound" page on your simulation platform:
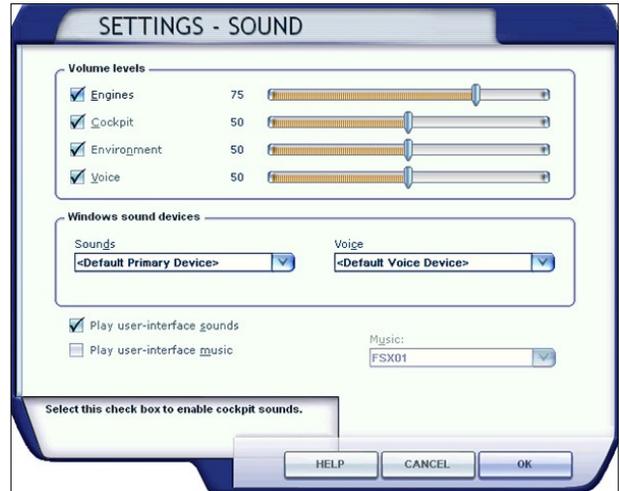
1. Under "Options" in the simulator's top menu bar, select **SETTINGS/SOUNDS...**

2. On the "Settings – Sound" page, under "Volume levels", adjust the volume levels for the engine and other sounds. Make sure all sounds are selected.

3. Click **OK** to close the "Settings – Sound" page.

To reduce the volume of the engine, try a setting of between 40% to 50%. If you like more rumble, noise and vibrations, try anything from 75% to 100%. A setting of about 75% seems acceptable for most computer sound systems and will produce the level of noise one would expect from a 60,000-pound rocket engine.

A little experimentation may be necessary in order to find the optimal settings, depending on your own sound system configuration and personal preferences.

Known Issues

- In addition to the basic aircraft sounds that are controlled by the simulator's own sound engine, the X-15A-2 SE addon features more than 50 extra sound effects, mainly cockpit sounds, that are managed by the addon's special systems but played by a third-party sound module. Due to software limitations, some cockpit sounds can still be heard from the external views or when the simulator is paused. Volume adjustment in the simulator has no effect on these sounds. This has no impact on the overall simulation.

- While we took great care to adjust the extra cockpit sound effects individually so they fit well in the overall sound mix, there is no separate control to adjust the volume of the extra cockpit sounds in this software version. This is mainly due to limitations in the current simulation platforms. However, it is possible to balance the extra cockpit sounds with the basic aircraft sounds that are controlled by the simulator by using the master volume control of your computer sound system. First, adjust the master volume on your computer so that the cockpit sounds are at a correct level. Cockpit sounds can be heard by clicking some of the switches, levers and knobs in the virtual cockpit. Then adjust the basic aircraft sounds in the "Settings – Sound" page, under "Volume Levels" for the proper balance. This has no impact on the overall simulation and needs to be done only once.

LOADING OR CREATING A FLIGHT

Unlike the real X-15A-2 airplane that was designed to be launched at a high altitude from a B-52 carrier airplane, the X-15A-2 SE addon can also take off from a runway like any other aircraft in the simulator. While this is perhaps unrealistic, taking off from the ground is rather fun and is something the real X-15 pilots could not do! Refer to "Typical X-15 Missions".

By default, the simulator loads the previously saved (or default) flight with the engine of the aircraft running. In the case of the X-15, it takes a split second for the simulator to "realize" that the rocket aircraft has not been serviced with the necessary propellants and to shut off the engine automatically. Because of the power of the mighty XLR-99 (and the rocket boosters on the X-15AD-4), the initial split second of thrust is enough to move the aircraft along the runway if the parking brake is not set.

While highly improbable in this software version, if the engine was not shut down automatically by the X-15A-2 integrated systems after the flight was loaded, simultaneously press the "**CTRL+SHIFT+F1**" keys on your keyboard to shut down the engine and apply the brakes to stop the aircraft on the runway. Set the parking brake ("**CTRL+.**") after the aircraft has stopped moving.

To avoid this problem, we recommend loading one of the saved flights included with the X-15A-2 SE addon as a "template" for a new flight. This has the advantage of presetting all

X-15 internal systems to off and preventing the rocket plane from moving by itself on the runway at the beginning of a flight because the engine was running and the parking brake was not set in the previous flight, in the last saved flight or in the default flight.

As an alternative, you can also create a new flight with a single-engine stock aircraft (one that comes with the simulator), turn off the engine ("**CTRL+SHIFT+F1**") and set the parking brake ("**CTRL+.**") . Replace the aircraft with the X-15A-2 SE and go to Edwards Air Force Base (or any other runway of your choice) and save this flight under a different name. Simply load this saved flight (or make it your default flight) each time you want to fly the X-15A-2 SE.

For your first X-15A-2 flight, you can either load a saved flight or create a flight.

LOADING A FLIGHT

You can load one of the saved flights included with the X-15A-2 SE addon as a "template" for a new flight. This has the advantage of presetting all X-15 internal systems to off and preventing the rocket plane from moving by itself on the runway at the beginning of a flight because the engine was running and the parking brake not set in the previous flight (refer to "Loading or Creating a Flight").

There are two categories of X-15A-2 SE flights: the "Takeoff" flights and the "Launch" flights. The takeoff flights are fictitious and the launch flights are based on actual X-15A-2 historical missions. Refer to "Saved Flights" for details.

For your first X-15A-2 flight, let's plan a normal takeoff from Ely Station, Nevada (KELY), runway 18, and a landing on Rogers Dry Lake at Edwards Air Force Base (KEDW). This departure location should give you an almost direct path to Edwards.

Like in a real X-15 mission, we will attempt to land our X-15A-2 addon on the lakebed runway, not the base concrete runway.

You can access the "Load Flight" (or "Load Scenario") page from the "Flights" (or "Scenario") menu item in the top menu bar in FSX or
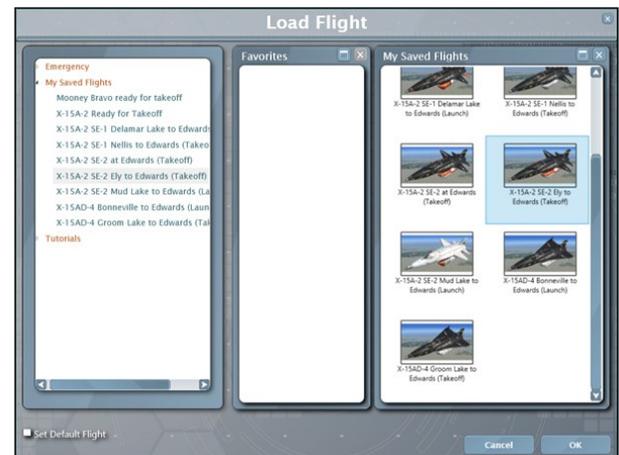
Prepar3D®. Select **LOAD...**

You can also access the "Load Flight" page from the "Free Flight" page in FSX:

1. Just above the aircraft preview window, select **LOAD**…

When on the "Load Flight" or "Load Scenario" page (FSX or Prepar3D®):

1. Select the following flight: **X-15A-2 SE-2 Ely to Edwards (Takeoff)**

2. Click the **FLY NOW!** (or **OK**) button to close the "Load Flight" (or "Load Scenario") page and start a new flight.

Note: The X-15A-2 SE saved flights are installed in your "C:\Users*your name**simulator name* Files" folder, on your computer. Refer to "Software Installation".

Known Issue (FSX in another language than English)

- If you are using Flight Simulator X in another language than English, you will need to manually move the saved flights from the "C:\Users*your name*\Documents\Flight Simulator X Files" folder to your "C:\Users*your name*\Documents*Flight Simulator X Files in your language*" folder. This is because Flight Simulator X changes the name of your saved flight folder, depending on your language. For example, while the folder name "Flight Simulator X Files" is used in English, it becomes "Fichiers Flight Simulator X" in French. The installer cannot detect the language of your simulation platform so you will have to copy or move the saved flight files manually. This is not an issue in Prepar3D®.

Note to FSX: Steam® Edition Users

- The X-15A-2 SE addon is fully compatible with Flight Simulator X: Steam® Edition. A special installer is available from our "Downloads" section (free for registered users). Please use this installer for installing your X-15A-2 SE addon in FSX: Steam® Edition. If not, the saved flights will be missing (see below).

- Please note that FSX: Steam® Edition is installed in a different way to the boxed version and occupies a different location on your computer. With the standard installer for FSX, you will need to copy the saved flights from the "C:\Users\your name\Documents\Flight Simulator X Files" folder to your "C:\Users\your name\Documents\Flight Simulator X - Steam Edition Files" folder. This is because FSX: Steam® Edition uses a different folder to store your saved flights.

- For these reasons, we recommend using the new installer for FSX: Steam® Edition that is available from our "Downloads" section.

Important

- You must be in the virtual cockpit view to operate this addon. The X-15A-2 SE has no 2D panels. If your addon appears to have no virtual cockpit, make sure you have selected the **VIRTUAL COCKPIT** view in the simulator, not the (2D) cockpit view. The virtual cockpit is available from the "Views" menu item on your simulation platform's top menu bar or by pressing the "**F9**" key. You can also cycle forward or backward the different views with both the "**S**" key and the "**A**" key or you can select the virtual cockpit as the default cockpit view when configuring your simulation platform.

Proceed to "Exterior Inspection".

CREATING A FLIGHT

For your first X-15A-2 flight, let's plan a normal takeoff from Ely Station, Nevada (KELY), runway 18, and a landing on Rogers Dry Lake at Edwards Air Force Base (KEDW). This depar-

ture location should give you an almost direct path to Edwards.

Like in a real X-15 mission, we will attempt to land our X-15A-2 SE addon on a lakebed runway, not on the base concrete runway.

Important

- You must be in the virtual cockpit view to operate this addon. The X-15A-2 SE has no 2D panels. If your addon appears to have no virtual cockpit, make sure you have selected the **VIRTUAL COCKPIT** view in the simulator, not the (2D) cockpit view. The virtual cockpit is available from the "Views" menu item on your simulation platform's top menu bar or by pressing the "**F9**" key. You can also cycle forward or backward the different views with both the "**S**" key and the "**A**" key or you can select the virtual cockpit as the default cockpit view when configuring your simulation platform.

CREATING A FLIGHT IN FLIGHT SIMULATOR X
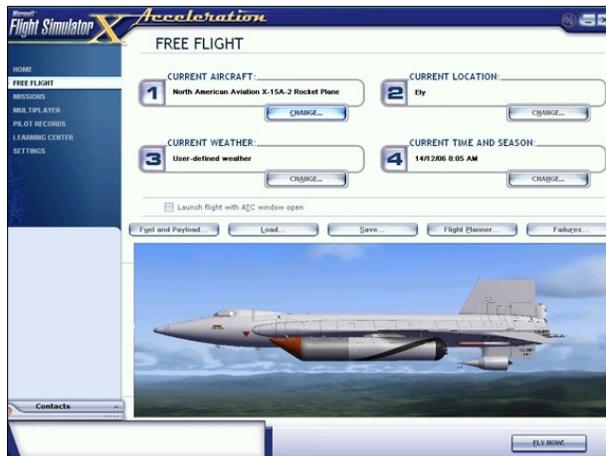
1. Select the **FREE FLIGHT** option in the menu at left.

2. On the "Free Flight" page, click **CHANGE** under "Current Aircraft" (1) to open the "Select Aircraft" page.

3. On the "Select Aircraft" page, enter/select

the followings:

  a. Aircraft manufacturer – **NORTH AMERICAN AVIATION.**
  b. Publisher – **XTREME PROTOTYPES, INC.**
  c. Aircraft type – **ALL.**
  d. Aircraft Model – **X-15A-2 ROCKET PLANE.**
  e. Variation – **CLEAN WHITE VERSION (CIRCA 1967)** – or any other available version of your choice.

4. Click **OK** to exit the "Select Aircraft" page.

5. On the "Free Flight" page, click **CHANGE** under "Selected Weather" (3) to open the "Weather" page.

6. On the "Weather" page, select **USER-DEFINED WEATHER**, then click the **CUSTOMIZE...** button.

7. On the "Customized Weather" page, enter the following conditions:

  a. Clouds – **CLEAR.**
  b. Precipitation – **NONE.**
  c. Visibility – **40 MI / 64 KM or UNLIMITED.**
  d. Wind Speed – **MODERATE (16 KTS).**
  e. Wind Direction – **210˚.**

8. Click **OK** twice to close both "Weather" pages.

9. On the "Free Flight" page, click **CHANGE** under "Current Time and Season" (4).

10. On the "Select Time and Season" page, set "Local Time" to: **08:12:00.**

11. On the "Select Time and Season" page, set date to: **JULY 8, 1965.**

12. Click **OK** to close the "Select Time ans Season" page.

13. On the "Free Flight" page, just above the aircraft preview window, click on the **FLIGHT PLANNER** button.

14. On the "Flight Planner" page, under the "Create" tab, enter/select:

   a. Departure location – **ELY (KELY), RUNWAY 18** (Ely – KELY, Nevada, United States, Runway 18).
   b. Destination – **EDWARDS AFB (KEDW)** (Edwards Air Force Base - KEDW, California, United States).
   c. Flight plan type – **VFR.**
   d. Routing – **Direct - GPS.**

15. Click the **FIND ROUTE** button.

16. Under the "Edit" tab, enter: Cruising Altitude – **45,000 feet.**

17. Click **OK** to save your flight plan.

18. Click **OK** to close the "Flight Planner" page. Answer **YES** when asked if you want the simulator to move your aircraft to the selected airport.

19. On the "Free Flight" page, just above the aircraft preview window, click the **SAVE...** button to save your flight. Name this flight: **X-15A-2 SE Ely Station to Edwards AFB.**

20. On the "Free Flight" page, click the **FLY NOW!** button to start your flight.

Note: You can also access the "Select Aircraft", "Customized Weather", "Select Time and Season" and "Flight Planner" pages from the top menu bar (under the "Flights", "Aircraft" and "Worlds" menu items).

You are now ready to fly. **Proceed to "Exterior Inspection".**

CREATING A FLIGHT IN PREPAR3D® v1

1. In the top menu bar, click "**AIRCRAFT**" and select "**SELECT AIRCRAFT**".

2. On the "Select Vehicle" page:

   a. Click the "**PUBLISHER**" button.
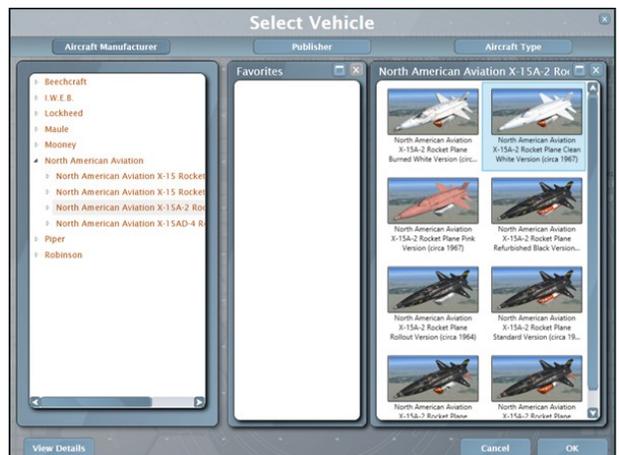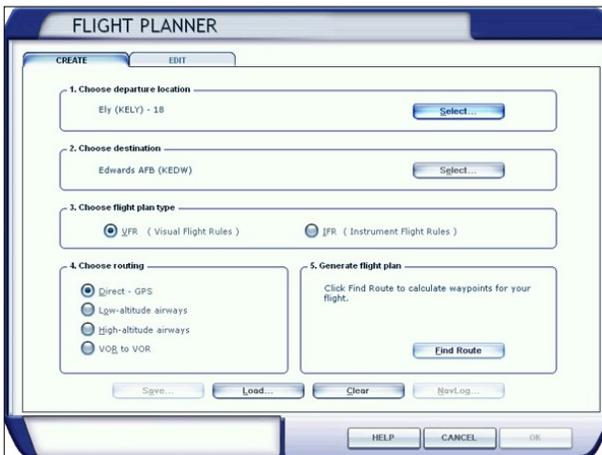
b. In the left panel, select "**XTREME PROTOTYPES, INC.**"

c. Under Xtreme Prototypes, select "**NORTH AMERICAN AVIATION X-15A-2 ROCKET PLANE**".

d. In the left or right panel, select "**CLEAN WHITE VERSION (CIRCA 1967)**" – or any other available version of your choice.

3. Click **OK** to exit the "Select Vehicle" page.

4. In the top menu bar, click "**WORLD**" and select "**WEATHER…**".

5. On the "Settings - Weather" page, select **USER-DEFINED WEATHER**, then click the **CUSTOMIZE…** button.

6. On the "Weather" page, enter the following conditions (make sure the "**ALL WEATHER STATIONS**" option is selected):

   a. Clouds – **CLEAR.**
   b. Precipitation – **NONE.**
   c. Visibility – **40 MI / 64 KM or UN-LIMITED.**
   d. Wind Speed – **MODERATE (16 KTS).**
   e. Wind Direction – **210˚.**

7. Click **OK** twice to close both "Weather" pages.

8. In the top menu bar, click "**WORLD**" and select "**TIME AND SEASON…**".

9. On the "Settings - Time and Season" page, set "Time" to: **08:12:00.**

10. On the "Settings - Time and Season" page, set date to: **JULY 8, 1965.**

11. Click **OK** to close the "Settings - Time and Season" page.

12. In the top menu bar, click "**FLIGHTS**" and select "**FLIGHT PLANNER…**".On the "Flight Planner" page, under the "Create" tab, enter/select:

   a. Departure location – **ELY (KELY), RUNWAY 18** (Ely – KELY, Nevada, United States, Runway 18).
   b. Destination – **EDWARDS AFB (KEDW)** (Edwards Air Force Base -

KEDW, California, United States).
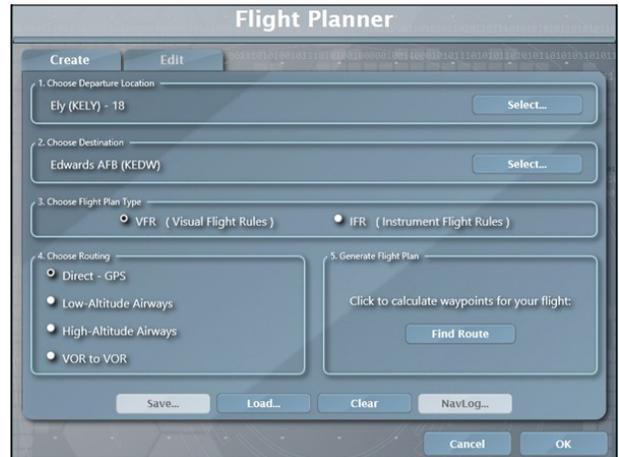
   c. Flight plan type – **VFR.**
   d. Routing – **Direct - GPS.**

13. Click the **FIND ROUTE** button.

14. Under the "Edit" tab, enter: Cruising Altitude – **45,000 feet.**

15. Click **OK** to save your flight plan.

16. Click **OK** to close the "Flight Planner" page. Answer **YES** when asked if you want the simulator to move your aircraft to the selected airport.

17. In the top menu bar, click "**FLIGHTS**" and select "**SAVE…**" to save your flight. Name this flight: **X-15A-2 SE Ely Station to Edwards AFB.**

You are now ready to fly. **Proceed to "Exterior Inspection".**

CREATING A FLIGHT IN PREPAR3D® v2 and later

1. In the top menu bar, click "**VEHICLE**" and select "**SELECT VEHICLE**".

2. On the "Select Vehicle" page:

   a. Under "Vehicle Title", select "**X-15A-2 CLEAN WHITE VERSION (1967)**" – or any other available version of your choice.

3. Click **OK** to exit the "Select Vehicle" page.

4. In the top menu bar, click "**WORLD**" and select "**WEATHER…**".

5. On the "Settings - Weather" page, select **USER-DEFINED WEATHER**, then click the **CUSTOMIZE…** button.

6. On the "Basic Weather" page, enter the following conditions (make sure the "**ALL WEATHER STATIONS**" option is selected):

   a. Clouds – **CLEAR.**
   b. Precipitation – **NONE.**
   c. Visibility – **40 MI / 64 KM or UN-LIMITED.**
   d. Wind Speed – **MODERATE (16 KTS).**
   e. Wind Direction – **210˚.**

7. Click **OK** twice to close both "Weather" pages.

8. In the top menu bar, click "**WORLD**" and select "**TIME AND SEASON…**".

9. On the "Settings - Time and Season" page, set "Time" to: **08:12:00.**

10. On the "Settings - Time and Season" page, set date to: **JULY 8, 1965.**

11. Click **OK** to close the "Settings - Time and Season" page.

12. In the top menu bar, click "**FLIGHTS** or **NAVIGATION**" and select "**FLIGHT PLAN-NER…**".On the "Flight Planner" page, under the "Create" or main tab, enter/select:

    a. Departure location – **ELY (KELY), RUNWAY 18** (Ely – KELY, Nevada, United States, Runway 18).
    b. Destination – **EDWARDS AFB (KEDW)** (Edwards Air Force Base - KEDW, California, United States).
    c. Flight plan type – **VFR.**
    d. Routing – **Direct - GPS.**

13. Click the **FIND ROUTE** button.

14. Under the "Edit" or main tab, enter: Cruising Altitude – **45,000 feet.**

15. Click **OK** or **SAVE** to save your flight plan.

16. Click **OK** to close the "Flight Planner" page (if still open). Answer **YES** when asked if you want the simulator to move your aircraft to the selected airport.

17. In the top menu bar, click "**FLIGHTS** or **SCENARIO**" and select "**SAVE...**" to save your flight. Name this flight: **X-15A-2 SE Ely Station to Edwards AFB.**

You are now ready to fly. **Proceed to "Exterior Inspection".**

EXTERIOR INSPECTION

Refer to "General Arrangement (X-15A-2)" for an exterior representation of the X-15A-2 SE

addon. It is recommended to familiarize yourself with the general external arrangement of the aircraft before proceeding. Refer to "Aircraft Description" for a complete description.

Note that because of the type of mission and the equipment used by the real X-15 pilot, it was not feasible for him to perform an exterior inspection of the aircraft before flight. This task was left to the ground personnel.

1. Select the **LOCKED SPOT** view ("**F11**" key on your keyboard).

This will allow you to inspect the exterior of the X-15A-2 SE. You can use the top hat button on your joystick (or the arrow keys on your numeric keypad) to move around the aircraft. Use the "**+**" or "**-**" keys on your keyboard to zoom in and out. Use the "**BACKSPACE**" key to reset the zoom.

If you loaded the black aircraft (like the one by default in the "Ely to Edwards" saved flight) and prefer the white aircraft like the one shown in this section, now is the time to switch aircraft:

1. In the top menu bar, click "**AIRCRAFT**" (or "**VEHICLE**") and select "**SELECT AIRCRAFT**" (or "**SELECT VEHICLE**").

2. Select "**NORTH AMERICAN AVIATION X-15A-2 ROCKET PLANE - CLEAN WHITE VERSION (CIRCA 1967)**" in the "Select Aircraft" (or "Select Vehicle") page.

3. Click "**OK**".

Basic flight procedures are the same for all aircraft.

The dummy ramjet (or ventral) [17-18, fig. 3-2] below the lower vertical stabilizer does not appear at this time to provide ground clearance and enough space for the rear landing skids [35, fig. 3-1]. The ramjet (or ventral) will appear later, when the landing gear is retracted after takeoff.

To open or close the canopy [9, fig. 3-1], simultaneously press the "**SHIFT-E**" keys on your keyboard.

Take a look inside the cockpit. Note that the

pilot is wearing the David Clark A/P22S-2 full-pressure suit and helmet, released in early 1961, an improvement over the earlier MC-2 suit used at the beginning of the X-15 program.

Known Issue (FSX, Prepar3D® v1)

- Due to limitations in FSX and Prepar3D® v1, it is possible to observe the movement of the control surfaces, including the speed brakes, without the APUs operating and providing hydraulic power to the motors. Of course, this was not possible on the real aircraft. Fortunately, this is no longer an issue in Prepar3D® v2 and later.

In FSX and Prepar3D® v1, it is possible to observe the movement of the control surfaces, including the speed brakes, at this time. On the real aircraft, this would not be possible without the APUs operating and providing enough hydraulic power to the motors. This is not possible in Prepar3D® v2 and later until the APUs are started which is conform to the normal mode of operation of the real aircraft.

1. Use your joystick (and/or rudder pedals) to control and observe the movement of the upper vertical stabilizer [4, fig. 3-1] and of the horizontal stabilizer [1, fig. 3-1]. Note that there are no ailerons on the X-15. The left and right sections of the horizontal stabilizer move simultaneously for pitch control, differentially for roll control, and in compound for pitch-roll control.

2. To open or close the speed brakes [3, 34, fig. 3-1], press the "/" key on your keyboard. The speed brakes can also be opened, closed and adjusted by using the speed brake handles [13-14, fig. 5-4] on the left console in the virtual cockpit.

At this time, the X-15A-2 SE has not yet been serviced and the engine should be shut down. While highly improbable in this software version, if the engine was started by the simulator and was not shut down automatically by the X-15A-2 SE internal systems, do the following procedure to shut down the engine:

1. Simultaneously press the "**CTRL-SHIFT-F1**" keys on your keyboard.

No visual effects (associated with aircraft lights or systems) such as engine flames, APU exhaust "smoke", or frost on the fuselage should be observed around the airplane at this time. Again, while highly improbable in this software version, if such effects are visible, do the following procedure to turn off the unwanted effects:

1. Press the "**L**" key (the simulator's "All Lights ON/OFF" command) on your keyboard as necessary, until all effects disappear.

Return to the "**VIRTUAL COCKPIT**" ("**F9**" key on your keyboard).

SPECIAL VISUAL EFFECTS

The X-15A-2 SE addon features 26 new special visual effects, including low speed/altitude and high speed/altitude effects.

Because there are no external lights or smoke system on the X-15 airplane, the X-15A-2 SE addon uses available aircraft lights and systems to display visual effects instead of conventional lights. For example, the No. 2 APU exhaust effect appears when the aircraft navigation lights are turned on by the X-15A-2 SE custom systems (when the No. 2 APU is on). Triggering the special visual effects is done internally and automatically. It is transparent to the user.

The following is a list of aircraft lights and systems and their corresponding X-15 visual ef-

fects:

- **Aircraft smoke system:** XLR-99 rocket engine flame effect.

- **Cabin lights:** XLR-99 first and second stage igniter effects.

- **Wing lights:** Turbopump hydrogen peroxide jettison effect.

- **Recognition lights:** Turbopump exhaust effect.

- **Taxi lights:** Condensation vapor effect around the (cold) internal liquid oxygen tank when filled.

- **Strobe lights:** No. 1 APU exhaust effect.

- **Navigation lights:** No. 2 APU exhaust effect.

- **Beacon lights:** Liquid oxygen jettison effect in addition to engine precool and prime effects.

- **Logo lights:** Ammonia jettison effect in addition to prime effect.

- **Aircraft contrail:** X-15 rocket engine contrail effects.

Note: Aircraft lights are used to display low speed/altitude visual effects (when the aircraft sits on the ground or fly at low speed). High speed/altitude visual effects are attached to aircraft parts in the 3D model and are independent from aircraft lights.

Known Issue (All Platforms)

- No visual effects should be observed around the airplane at the beginning of a new flight. While improbable in this software version, if such effects are visible, do the following procedure to turn off the unwanted effects:

    1. Press the "**L**" key (the simulator's "All Lights On/Off" command) on your keyboard as necessary, until all effects disappear.

Known Issue (FSX)

- If the special visual effects on your system don't look like the ones shown in this manual, uncheck the Preview DirectX® 10 option box in FSX's display settings. FSX seems to perform better under DirectX® 9. Third-party free DirectX® 10 shader fixers are also available in FSX forums. For more information, refer to "Recommended Settings for Flight Simulator X".

View Aspect Ratio Issue (FSX, FSX: Steam® Edition, Prepar3D® v1)

- The special visual effects (engine flames, contrails, APU exhaust, etc.) included with your X-15A-2 SE addon should look like the ones shown in this manual.

- Changing the view aspect ratio on your simulation platform may affect the appearance of the special visual effects (we believe this to be a minor simulator issue, not an addon issue). For more information about changing the view aspect ratio, refer to the recommended settings for Flight Simulator X and Prepar3D® v1 in section 2.

- The special effects for Flight Simulator X and Prepar3D® v1 are optimized for a wide-view aspect ratio. If you are using a standard-view aspect ratio, the effects may appear too small (or too thin). To solve this issue, simply replace the default effects with the ones included in the "FSX Steam Effects (1.65)" folder contained in the Special Effects Package. Visit the "Downloads" section on our website and download the Special Effects Package. Read the instructions included with the Special Effects Package.

- The special effects for Flight Simulator X: Steam® Edition are optimized for a standard-view aspect ratio. If you are using a wide-view aspect ratio, the effects may appear too big (or too large). To solve this issue, simply replace the default effects

with the ones included in the "FSX P3Dv1 Effects (1.00)" folder contained in the Special Effects Package. Visit the "Downloads" section on our website and download the Special Effects Package. Read the instructions included with the Special Effects Package.

- No special effect issue related to the view aspect ratio was reported in Prepar3D® v2 and later.

Known Issue (All Platforms)

- The special visual effects (engine flames, contrails, APU exhaust, etc.) included with your X-15A-2 SE addon should look like the ones shown in the documentation.

- For reasons that are sometimes hard to define, special effects appearance may vary from system to system, depending on many factors including your simulation platform, your version of DirectX®, your view aspect ratio, your frame rate and your graphics hardware and settings. If, after trying different settings (see "Compatibility, Performance and Settings"), you are still not satisfied with the effects on your system (for example, they are too big or too small), try replacing the special effect files.

- Visit the "Downloads" section on our website and download the Special Effects Package. Try the different effects by copying them to your "... *simulator name*\Effects" folder. Read the instructions included with the Special Effects Package.

- Please note that the addon version for Prepar3D® v4 contains a new set of special effects. Previous issues are now fixed.

Known Issue (Prepar3D v2/3 with DirectX® 11, FSX: Steam® Edition)

- The special effect engine was changed from CPU to GPU with the release of Prepar3D® v2. This has the advantage of freeing computer resources and improving performance on high-end graphics hardware. The X-15A-2 SE special visual effects were upgraded to conform to the

Prepar3D® v2 specifications. While the new Prepar3D® v2 particle effects are visually identical to the FSX/Prepar3D ®v1 effects, there is a simulator issue affecting extrusion effects that still needs to be resolved.

SERVICING THE AIRCRAFT

In the real world, propellants and gases were loaded onto both the B-52 carrier and the X-15A-2 by ground personnel before each flight. During captive flight (while the rocket plane was attached to the B-52 and gaining altitude), the X-15A-2 internal liquid oxygen tank was topped off from the carrier airplane supply.

To simulate the complex servicing of the X-15A-2 rocket plane, both from the ground and from the B-52 carrier, a simplified (fictitious) service panel is provided. The service panel is located in the upper section of the center pedestal in the virtual cockpit.

Until then, extrusion effects such as engine contrails, wing vortices and vapor-trails, APU exhaust and propellant jettison effects at high speed and altitude may appear sawtoothed, wrongly oriented, faded, delayed, with repeating arrow patterns. This is normal until a fix is made available.

- For other reasons, we noticed a similar issue in FSX: Steam® Edition, to a lesser degree. This is normal until a fix is made available.

Servicing the X-15A-2 is achieved by the click of a single button on the service panel. The service panel also includes an external power switch to provide electrical power from an external source before takeoff or launch, an external tanks option switch and an unlimited

fuel option switch.

Refer to "Service Panel" for more information.

External Power

The service panel provides electrical power to the X-15 aircraft before the APUs can be turned on. This simulates electrical power being supplied to the X-15 either from a ground receptacle or from the carrier airplane:

1. External power switch [22, fig. 5-3] – **ON.**

2. External power (green) light [23, fig. 5-3] – Check **ON.**

Electrical systems can be monitored on the system monitor panel, available from the "Views/Instrument Panel" menu item on your simulation platform's top menu bar (see below).

Service Panel Options

In a real X-15A-2 mission, a normal burnout occurs after approximately 90 seconds (no external tanks) to 150 seconds (external tanks installed) of XLR-99 engine operation, after the propellants are exhausted. This is the default mode of operation in the simulator.

An "unlimited fuel" option switch is provided, on the service panel, to allow for unlimited-duration burns. Simply turn the two-position switch [27, fig. 5-3] to **ON** if you prefer this mode of operation:

1. Unlimited fuel option switch [27, fig. 5-3] – **ON** or **OFF** (your choice).

Note: As long as the engine master switch [63, fig. 5-1] is set to **OFF**, the fuel consumption can be reset to normal at any time by returning the unlimited fuel option switch to the **OFF** position. The switch position cannot be changed if the engine master switch is set to **ON.**

An external tanks option switch [26, fig. 5-3], on the service panel, is provided for choosing whether or not the X-15A-2 external drop tanks are installed. Make sure this switch is set to **INSTALLED** for true X-15A-2 operation

(external tanks installed):

2. External tank option switch [26, fig. 5-3] – **ON.**

Note: The external tanks option switch cannot be set if the propellant tanks are pressurized (vent, pressurize, and jettison lever [11, fig. 5-4] not at **VENT**).

Note: The X-15A-2 external tanks provide an additional 1053 gallons of anhydrous ammonia and 770 gallons of liquid oxygen which corresponds approximately to an additional 60 seconds of engine burn time.

One-Step Servicing

An "express fill" button is provided, on the service panel, to accelerate servicing procedures and concurrently fill all internal and external tanks in a single operation. Each tank can be monitored on the system monitor panel, available from the "Views/Instrument Panel" menu item on your simulation platform's top menu bar (see below).

To service the X-15A-2 SE, proceed as follows:

1. Express fill button [24, fig. 5-3] – **Push (once).** All tanks will be filled simultaneously.

2. Empty tank caution (amber) light [25, fig. 5-3] – Check, should come **OFF.**

Check for Proper Filling on the System Monitor Panel

Check each tank, on the system monitor panel, for proper filling:

"Engine Propellants" section:

1. Ammonia tanks – **Check (internal tank, 1445 gallons; external tank, 1053 gallons).**

2. Liquid oxygen tanks – **Check (internal tank, 1017 gallons; external tank, 770 gallons).**

3. Turbopump hydrogen peroxide (H_2O_2) tank – **Check (118 gallons).**

"Helium" section:

4. Propellant source (helium) tanks – **Check (both internal and external tanks, 3200-3800 psi)**.

5. Engine and propellant control source (helium) tanks – **Check (both internal and external tanks, 3200-3800 psi)**.

6. Auxiliary pneumatic and control (helium) tank – **Check (3200-3800 psi).**

"Auxiliary Power Units" section:

7. APU H_2O_2 tanks – **Check (60-75 gallons, both systems)**.

8. APU propellant source (helium) tanks – **Check (3200-3800 psi, both systems).**

"Air Conditioning and Pressurization" section:

9. Liquid nitrogen tank – **Check (25-30 gallons).**

10. Cabin helium tank – **Check (3200-3800**

psi).

11. Pilot's oxygen cylinders (seat) – **Check (3000-3200 psi).**

12. Pilot's oxygen cylinders (emergency) – **Check (1800-2000 psi).**

Note: The tanks will be topped off automatically to prevent overfill.

PREFLIGHT CHECKS

Important

■ A wheelmouse is required to actuate the 3-position switches. Refer to "Minimum System Requirements".

■ It sometimes occurs that the pilot's viewpoint is adjusted too far back and lays inside the pilot seat's backrest, rendering the switches unclickable. When this happens, simply move your viewpoint forward a little.

■ Some switches must be activated in a logical, predetermined order or sequence to

function. If not, the switch is simply disabled and will not respond to mouse clicks. If a switch refuses to operate normally, please revise the previous procedures and make sure that all the required steps have been performed in the correct order. These switches are:

a) The external drop tanks option switch [26, fig. 5.3] on the service panel section of the center pedestal - can only be moved if the vent, pressurization, and jettison lever [11, fig. 5.4] on the left white control box is at **VENT**.

b) The unlimited fuel option switch [27, fig. 5.3] on the service panel section of the center pedestal - cannot be moved when the engine master switch [63, fig. 5.1] on the main panel is at **ON**.

c) The igniter-idle switch [53, fig. 5.1] on the main panel - cannot be moved if the engine turbopump is not running.

Preflight Checks

For the following procedures, it is assumed that external power is supplied to the aircraft (external power switch [22, fig. 5-3] set to **ON**) and that the X-15 internal and external tanks are filled. Refer to "Servicing the Aircraft" for details.

Note: You can hide the center stick for a better access to the center pedestal controls by clicking the center stick boot [9, fig. 4-1].

1.   Parking brake (if released, takeoff only) – **APPLIED ("CTRL+." keys).**

Left console, seat and wing panel:

1.   Trim control switch [1, fig. 5-4] – **CENTER.**

2.   Intercom switch [2, fig. 5-4] – **OFF.**

3.   Face mask heater switch [3, fig. 5-4] – **OFF.**

4.   Jettison trim switch [4, fig. 5-4] – **OFF.**

5.   Vent suit heater switch [6, fig. 5-4] – **OFF.**

6.   Pressure suit ventilation knob [4, fig. 5-4] – **CLOSED.**

7.   Radio function selector switch [1, fig. 5-8] – **OFF.**

8.   Tank jettison circuit breakers [1-2, fig. 5-6] – **OFF/OPEN (aft).**

9.   External tanks jettison auto-manual switch [3, fig. 5-6] – **MANUAL.**

10. External tanks jettison safe-arm switch [4, fig. 5-6] – **SAFE (guard down).**

11. External tanks jettison buttons [5-6-7, fig. 5-6] – **Check all (normal).**

12. Fuel selector switch [8, fig. 5-6] – **EXTERNAL.**

13. Speed brake handles [13-14, fig. 5-4] – **CLOSED (forward).**

14. Wing flap switch [9, fig. 5-4] – **UP.**

15. Alternate SAS switch [16, fig. 5-4] – **OFF (guard down).**

16. RAS (amber) indicator lights [10, fig. 5-4] – **Check all OFF** (RAS functions are off).**.**

17. Vent, pressurize, and jettison control lever [11, fig. 5-4] – **VENT.** On a real mission, the vent valve on the internal ammonia tank is manually closed before flight to prevent losing ammonia during captive flight (when the X-15A-2 is attached to the B-52 carrier). When the vent, pressurize, and jettison control lever is placed in the

PRESSURIZE or JETTISON position and then back to VENT, the ammonia vent valve will then be open.

18. Throttle [12, fig. 5-4] – **OFF**.

19. SAS (land) disengage switch [77, fig. 5-1] – **OFF.**

20. SAS (autopilot) power switch [78, fig. 5-1] – **OFF.**

21. Jettison stop switches [59, fig. 5-1] – **STOP.** Check that all three switches (LOX, H$_2$O$_2$, and NH$_3$) are in the **STOP** position.

22. Auxiliary launch switch [60, fig. 5-1] – **OFF (guard down).**

23. Ventral jettison button [67, fig. 5-1] – **Check (normal).**

24. Landing gear handle [65, fig. 5-1] – **NOR-MAL for takeoff.**

25. Eyelid handle [6, fig. 4-3] – **FORWARD** (eyelid open).

26. Oxygen selector and gauge (on the left side of the seat) [18, fig. 4-2] – **B-52, check (3000-3200 psi).**

Main instrument panel:

1. Ignition-ready (green) light [2a, fig. 5-1] – **Check OFF.**

2. 23-second caution (amber) light [2b, fig. 5-1] – **Check OFF.**

3. Idle-end caution (amber) light [2c, fig. 5-1] – **Check OFF.**

4. Valve malfunction caution (amber) light [2d, fig. 5-1] – **Check OFF.**

5. Stage 2 igniter malfunction caution (amber) light [2e, fig. 5-1] – **Check OFF.**

6. Turbopump overspeed caution (amber) light [2f, fig. 5-1] – **Check OFF.**

7. Engine vibration malfunction caution (amber) light [2g, fig. 5-1] – **Check OFF.**

8. Fire-warning (red) light [47, fig. 5-1] – **Check OFF.**

9. Helium release selector switch [1, fig. 5-1] – **OFF.**

10. Propellant emergency pressurization switch [68, fig. 5-1] – **OFF.**

11. Ammonia tank pressure-low caution (amber) light [66, fig. 5-1] – **ON** (tank is not pressurized).

12. Liquid oxygen tank pressure-low caution (amber) light [70, fig. 5-1] – **ON** (tank is not pressurized).

13. Propellant (helium) source pressure gauge [69, fig. 5-1] – **Check (both internal and external tanks, 3300 to 3700 psi).**

14. Engine master switch [63, fig. 5-1] – **OFF.**

15. Engine reset button [62, fig. 5-1] – **Check (normal).**

16. Engine precool switch [61, fig. 5-1] – **OFF.**

17. Engine prime switch [56, fig. 5-1] – **STOP PRIME (DOWN).**

18. Turbopump idle button [54, fig. 5-1] – **Check (normal).**

19. Igniter idle switch [53, fig. 5-1] – **OFF.**

20. Propellant tank pressure gauge [71, fig. 5-1] – **Check (liquid oxygen or "L" pointer, 0 to 5 psi; ammonia or "A" pointer, 0 to 10 psi).**

21. Propellant pump inlet pressure gauge [72, fig. 5-1] – **Check (both pointers, 0 to 10 psi).**

22. Fuel line low caution (amber) light [64, fig. 5-1] – **Check OFF.**

23. H$_2$O$_2$ (helium) source and purge pressure gauge [57, fig. 5-1] – **Check (both internal and external tanks, 3000 to 3700 psi).**

24. H$_2$O$_2$ tank and engine control line pressure gauge [55, fig. 5-1] – **Check ("C" pointer, 575 to 615 psi; "T" pointer, 0 psi).**

25. Propellant manifold pressure gauge [51, fig. 5-1] – **Check (both pointers, 0 to 10 psi).**

26. H_2O_2 compartment-hot caution (amber) light [58, fig. 5-1] – **Check OFF.**

27. Chamber and stage 2 igniter pressure gauge [50, fig. 5-1] – **Check (both pointers, 0 psi).**

28. Pilot's O2 low caution (amber) light [6, fig. 5-1] – **Check OFF.**

29. External tanks jettison ready indicator (amber) lights [4, fig. 5-1] – **Check both OFF.**

30. External tanks fuel flow indicator [4, fig. 5-1] – **Check (both pointers, 0%).**

31. SAS pitch function switch [5, fig. 5-2] – **STD BY.**

32. SAS roll function switch [6, fig. 5-2] – **STD BY.**

33. SAS test switch [7, fig. 5-2] – Check **OFF (middle).**

34. SAS yar function switch [8, fig. 5-2] – **STD BY.**

35. SAS yaw function switch [9, fig. 5-2] – **STD BY.**

36. SAS caution (amber) lights (four) [1-4, fig. 5-2] – **Check all ON** (SAS functions are off).

37. Alt SAS switch [11, fig. 5-2] – **OFF.**

38. Alt SAS on (green) light [10, fig. 5-2] – **Check OFF.**

39. RAS pitch function switch [13, fig. 5-2] – **OFF.**

40. RAS roll function switch [14, fig. 5-2] – **OFF.**

41. RAS yaw function switch [15, fig. 5-2] – **OFF.**

42. RAS auto cutoff switch [16, fig. 5-2] – **OFF.**

43. RAS out (amber) light [12, fig. 5-2] – **ON** (RAS functions are off).

44. Retractable pitot handle [80, fig. 5-1] – **IN.**

45. Skylight hatch open (amber) light [73, fig. 5-1] – **Check OFF.**

46. Automatic ignition sequence start button [76, fig. 5-1] – **Check (normal).**

47. Ready-to-launch switch [52, fig. 5-1] – **OFF.**

48. Engine timer [11, fig. 5-1] – **RESET.**

Main instrument panel (flight instruments):

1. Accelerometer [8, fig. 5-1] – **Reset and check.**

2. Altimeter [3, fig. 5-1] – **Set.**

3. Attitude indicator [9, fig. 5-1] – **Set.**

4. Side-slip selector (delta psi) switch [12, fig. 5-1] – **STANDBY.**

5. Pitch angle set control [16, fig. 5-1] – **+0.00.**

Main instrument panel (electrical, hydraulic, and cockpit):

1. Emergency battery switch [23, fig. 5-1] – **OFF (guard down).**

2. Hydrogen peroxide transfer switch [24, fig. 5-1] – **OFF.**

3. No. 1 generator-out (amber) light [20, fig. 5-1] – **Check ON** (generator not in operation).

4. No. 2 generator-out (amber) light [25, fig. 5-1] – **Check ON** (generator not in operation).

5. Generator (AC) voltmeter [22, fig. 5-1] – **Check (both pointers, 200 volts, external).**

6. No. 1 and No. 2 generator switches [21, 26, fig. 5-1] – **OFF.**

7. APU No. 1 switch [17, fig. 5-1] – **OFF.**

8. APU No. 1 warning and caution lights [28, 29, 31, fig. 5-1] – **Check OFF.**

9. No. 1 ballistic control switch [18, fig. 5-1] – **OFF.**

10. No. 2 ballistic control switch [27, fig. 5-1] – **OFF.**

11. APU No. 2 warning and caution lights [28, 29, 31, fig. 5-1] – **Check OFF.**

12. APU No. 2 switch [30, fig. 5-1] – **OFF.**

13. APU (helium) source pressure gauge [45, fig. 5-1] – **Check (both pointers, 3300 to 3900 psi).**

14. APU H_2O_2 pressure gauge [44, fig. 5-1] – **Check (both pointers, 0 psi).**

15. Hydraulic pressure gauge [13, fig. 5-1] – **Check (both pointers, 0 psi).**

16. Clock [46, fig. 5-1] – **Check and set.**

17. Mixing chamber temperature gauge [42, fig. 5-1] – **Check (approx. ambient temperature).**

18. APU bearing temperature gauge [43, fig. 5-1] – **Check (approx. ambient temperature).**

19. Cabin (helium) source pressure gauge [40, fig. 5-1] – **Check (3300 to 3900 psi).**

20. Cabin pressure altimeter [41, fig. 5-1] – **Check.**

Center pedestal (service panel):

1. External power switch [22, fig. 5-3] – **ON.**

2. External power (green) light [23, fig. 5-3] – Check **ON.**

3. External tank option switch [26, fig. 5-3] – **ON.**

4. Unlimited fuel option switch [27, fig. 5-3] – **ON** or **OFF** (your choice).

Center pedestal (research instrumentation panel):

1. Auxiliary pneumatic and control (helium) pressure gauge [21, fig. 5-3] – **Check (3000 to 3700 psi).**

2. Data switch [1, fig. 5-3] – **OFF.**

3. Data (amber) light [2, fig. 5-3] – **Check OFF.**

4. Calibrate button and (green) light [3, fig. 5-3] – **Check (normal).**

5. Physiological instrumentation switch [4, fig. 5-3] – **OFF.**

6. Blood pressure switch [5, fig. 5-3] – **OFF.**

7. Ball nose power switch [6, fig. 5-3] – **OFF.**

8. Ball nose test button [7, fig. 5-3] – **Check (normal).**

9. Telemeter master power switch [18, fig. 5-3] – **OFF.**

10. Telemeter commutator motor switch [17, fig. 5-3] – **OFF.**

11. Telemeter FM switch [8, fig. 5-3] – **OFF.**

12. Skylight hatch switch [19, fig. 5-3] – **OFF** (skylight hatch closed).

13. Star tracker switch [20, fig. 5-3] – **OFF.**

14. Instrumentation master power switch [15, fig. 5-3] – **OFF.**

15. Radar beacon switch [14, fig. 5-3] – **OFF.**

16. Stable platform instrument switch [10, fig. 5-3] – **OFF.**

17. Tape recorder power switch [9, fig. 5-3] – **OFF.**

18. Cockpit ram-air knob [11, fig. 5-3] – **OFF (in)**

19. Ram-air lever [16, fig. 5-3] – **OPEN.**

20. DC voltmeter selector switch [13, fig. 5-3] – **BUS** or **STRAIN GAGE** (select for testing).

21. DC voltmeter [12, fig. 5-3] – **Check (28-volt bus, or 24-volt strain gauge/battery bus).**

Right console and wing panel:

1. Canopy emergency release handle [32, fig. 5-1] – **IN.**

2. Stable platform switch [33, fig. 5-1] – **OFF (guard in place).**

3. Nose ballistic rocket heater switch [34, fig. 5-1] – **OFF.**

4. Ventral arming switch [35, fig. 5-1] – **DE-ARM (guard down).**

5. Cockpit lighting switch [39, fig. 5-1] – **OFF.**

6. Indicator, caution, and warning light test switch [38, fig. 5-1] – **OFF.**

7. Fire-warning light test button [37, fig. 5-1] – **Check (normal).**

8. Windshield heater switches (two) [36, fig. 5-1] – **OFF.**

9. Canopy internal handle [1, fig. 5-5] – **FORWARD and LOCKED (canopy closed)**.

10. Windshield antifogging (yellow) handle [2, fig. 4-3] – **CLOSED (vertical) position.**

11. Windshield purge (gray) handle [3, fig. 4-3] – **CLOSED (vertical) position.**

12. All breakers on the breaker panel – **PUSHED IN (closed).**

13. Pressure-cooling lever [9, fig. 5-9] – **OFF (aft position).**

14. Blower switches [10, fig. 5-9] – **OFF (middle position).**

15. Cabin helium source shutoff valve switch [11, fig. 5-9] – **OFF.**

16. APU nitrogen cooling switch [17, fig. 5-9] – **OFF.**

17. Alternate cabin pressurization switch [27, fig. 5-9] – **OFF.**

CAPTIVE TAXI AND FLIGHT

On a real mission, the following procedures are done before taxi of the carrier airplane:

1. Cockpit lighting switch [39, fig. 5-1] – **ON.**

2. Face mask heater switch [3, fig. 5-4] – **As required.**

3. Vent suit heater switch [6, fig. 5-4] – **As required.**

4. Pressure suit ventilation knob [4, fig. 5-4] – **As required.**

5. Radio function selector switch [1, fig. 5-8] – **Turn ON, one step right to MAIN TR1, AUX. ADF.** This also turns on the aircraft avionics. Refer to "Radio Communication and ADF/VOR Controls" for radio operating instructions. The simulator's ATC window can be opened by clicking the red microphone switch on the center stick [8, fig. 4-1].

6. Instrumentation master power switch [15, fig. 5-3] – **ON.**

7. Data switch [1, fig. 5-3] – **ON.**

8. Data (amber) light [2, fig. 5-3] – **Check BLINKING.**

9. Calibrate button and (green) light [3, fig. 5-3] – **Push once to calibrate (normal).**

10. Physiological instrumentation switch [4, fig. 5-3] – **ON.**

11. Blood pressure switch [5, fig. 5-3] – **ON.**

12. Telemeter master power switch [18, fig. 5-3] – **ON.**

13. Telemeter commutator motor switch [17, fig. 5-3] – **ON.**

14. Telemeter FM switch [8, fig. 5-3] – **ON.**

15. Radar beacon switch [14, fig. 5-3] – **ON.**

16. Stable platform instrument switch [10, fig. 5-3] – **ON.**

17. Tape recorder power switch [9, fig. 5-3] – **ON.**

18. DC voltmeter selector switch [13, fig. 5-3] – **BUS.**

19. DC voltmeter [12, fig. 5-3] – **Check (28-volt bus).**

20. Stable platform switch [33, fig. 5-1] – **EXT (middle position, guard removed).** This will energize the stable platform.

Interior Inspection and Operational Check

1. Oxygen selector and gauge (on the left side of the seat) [18, fig. 4-2] – **B-52, check (3000-3200 psi).**

2. Seat restraints and handles – **Check (normal for flight).** Refer to Fig. 4-2.

3. Calibrate instrumentation button and light [3, fig. 5-3] – **Push once** (button green light should come **ON** for about 3 seconds, then **OFF**, indicating instrumentation calibration).

4. Ready-to-launch switch [52, fig. 5-1] – **Test ON.** Ready-to-launch indicator light in the B-52 should come ON. **Return to OFF after test.**

5. Indicator, caution and warning lights – **Check.** Place the indicator, caution, and warning light test switch [39, fig. 5-1] at **TEST** (up position). All indicator, caution, and warning lights (except the fire warning light and the press-to-test lights) will come **ON**. This is only a test of the bulbs. Return the switch to **NORMAL** (down position). The press-to-test lights in the cockpit can be tested by pressing (left-clicking with the mouse) the light housing. Left-clicking with the mouse a second time will return the light to its normal operating state.

6. Fire-warning light test button [37, fig. 5-1] – **Push to test.** Fire-warning (red) light [47, fig. 5-1] ON indicates continuity of detection circuit.

7. Center control stick [41, fig. 5-1] – **Check joystick (stick centered, joystick throttle to MIN).**

8. Head restraint [8, fig. 4-3] – **STOWED (up position).**

TAXI (CARRIER)

On a real mission, the following procedures are done during taxi of the carrier airplane:

Testing the SAS Lights

1. SAS lights check – Move SAS function switches [5, 6, 8, 9, fig. 5-2] to **LO GAIN** and check the SAS lights [1-4, fig. 5-2] (should come OFF). Return function switches to **STD BY** after each function trips.

Operation of Ram-Air and Augmented Cooling System (Captive Flight)

To operate the ram-air and augmented cooling systems, proceed as follows:

1. Cabin source helium shutoff valve switch [11, fig. 5-9] - **OFF**.

2. APU cooling switch [17, fig. 5-9] - **SINGLE**.

3. Pressure cooling lever [9, fig. 5-9] - **OFF.**

4. X-15 LN_2 supply switch (B-52) - Check **OPEN**. Check with launch operator that switch is **OPEN**.

5. Stable platform LN$_2$ cooling control switch (B-52) - Check **OFF**. Check with launch operator that switch is **OFF**.

6. Blower switches [10, fig. 5-9] - **OFF**.

7. Ram-air lever [16, fig. 5-3] - **OPEN**.

BEFORE TAKEOFF (CARRIER)

On a real mission, the following procedures are done before takeoff of the carrier airplane:

1. Helium release selector switch [1, fig. 5-1] – **AUTO.**

2. Jettison stop switches [59, fig. 5-1] – **STOP (all three switches).**

3. Propellant source pressure gauge [69, fig. 5-1] – **Check (both internal and external tanks, 3300 to 3800 psi).**

4. Propellant tank pressure gauge [71, fig. 5-1] – **Check (pointer "L", 0 to 5 psi; "A", 0 to 10 psi).**

5. Propellant pump inlet pressure gauge [72, fig. 5-1] – **Check (pointer "L", 0 to 5 psi; "A", 0 psi).**

6. Chamber and stage 2 igniter pressure gauge [50, fig. 5-1] – **Check (both pointers, 0 psi).**

7. H$_2$O$_2$ source and purge pressure gauge [57, fig. 5-1] – **Check (both internal and external tanks, 3000 to 3900 psi).**

8. H$_2$O$_2$ tank and engine control line pressure gauge [55, fig. 5-1] – **Check ("C" pointer, 575 to 615 psi; "T" pointer, 0 psi).**

9. Tank jettison circuit breakers [1-2, fig. 5-6] – **OFF/OPEN (aft).**

10. External tanks jettison auto-manual switch [3, fig. 5-6] – **MANUAL.**

11. External tanks jettison safe-arm switch [4, fig. 5-6] – **SAFE (guard down).**

12. External tanks jettison buttons [5-6-7, fig. 5-6] – **Check all (normal).**

13. Fuel selector switch [8, fig. 5-6] – **MANUAL.**

14. External tanks jettison ready indicator (amber) lights [4, fig. 5-1] – **Check (press to test).**

TAKEOFF AND CLIMB (CARRIER)

Takeoff

On a real mission, during takeoff of the carrier airplane, the X-15 pilot monitors all instruments and relay any information that could affect the planned mission.

1. Ventral arming switch [35, fig. 5-1] – **ARM.**

2. Windshield heater switches (two) [36, fig. 5-1] – **Both switches ON.** The windshield heater switches should be moved to **ON** when fogging or frosting of the glass is observed and should remain ON until the airplane is landed.

3. Engine master switch [63, fig. 5-1] – **ARM.**

4. Engine reset button [62, fig. 5-1] – **Push (once).**

5. Engine precool switch [61, fig. 5-1] – **PRE-COOL.** Precool the engine, then turn the engine precool switch to **OFF** (on a real mission, the X-15 pilot would precool the engine for 10 minutes on, then 20 minutes off).

Climb

On a real mission, the following procedures are done after takeoff of the carrier airplane, during the climb and cruise part of the flight:

1. Instrumentation master power switch [15, fig. 5-3] – **Check ON.**

2. Telemeter master power switch [18, fig. 5-3] – **Check ON.**

3. Radio communications – **Check.** On a real mission, the X-15 pilot confirms radio communication with chase planes and ground station and also that communication is available between the X-15 airplane, chase planes, carrier airplane and ground station.

4. Nose ballistic rocket heater switch [34, fig. 5-1] – **ON.**

CRUISE AND CLIMB TO LAUNCH ALTITUDE (CARRIER)

On a real mission, during the cruise-climb to launch altitude, the pilot of the B-52 carrier starts the time-to-go sequence and confirms with the launch operator that the liquid oxygen top-off is satisfactory. The following procedures are performed at an altitude of between 35,000 to 45,000 feet:

Closing the Ram-Air Door

1. Ram-air lever [16, fig. 5-3] – **CLOSED.**

2. Cockpit ram-air knob [11, fig. 5-3] – **CLOSED (in).**
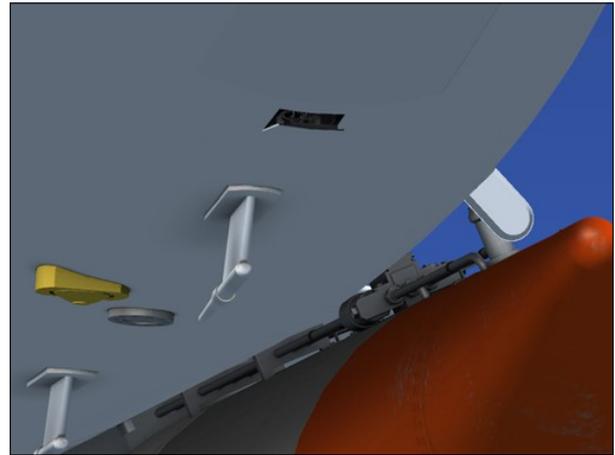
PRELAUNCH

On a real mission, the following procedures are done at cruising altitude, before count-down:

Operation of Augmented Cooling System

To operate the augmented cooling system, proceed as follows:

1. Cabin helium source shutoff valve switch [11, fig. 5-9] - **OFF**.

2. APU cooling switch [17, fig. 5-9] - **SINGLE** .

3. Pressure cooling lever [9, fig. 5-9] - **OFF**.

4. Windshield antifogging handle [2, fig. 4-3] - **OFF**.

5. X-15 LN_2 supply switch (B-52) - Check **OPEN**. Check with launch operator that switch is at **OPEN**.

6. Vent suit heater switch [6, fig. 5-4] - **HIGH** or **LOW, as required**.

7. Pressure suit ventilation knob [5, fig. 5-4] - **As required**. Knob should be open a minimum of one turn.

8. Stable platform LN_2 cooling control switch (B-52) - Check **OFF**. Check with launch operator that switch is **OFF**.

9. Ram-air lever [16, fig. 5-3] - **CLOSED**.

10. Blower switches [10, fig. 5-9] - **BLOWERS & LN$_2$** .

11. Mixing chamber temperature gage [42, fig. 5-1] - **CHECK**. When both chamber temperatures stabilize at -40˚ C (±5˚ C), proceed to step 12.

12. Stable platform switch [33, fig. 5-1] - **EXT**. Move stable platform switch to **EXT** and wait 10 minutes before proceeding to step 13.

13. Blower switches [10, fig. 5-9] - **BLOWER ONLY**.

14. Stable platform LN$_2$ cooling control switch (B-52) - Check **ON**. Check with launch operator that switch is **ON**.

BEFORE COUNTDOWN
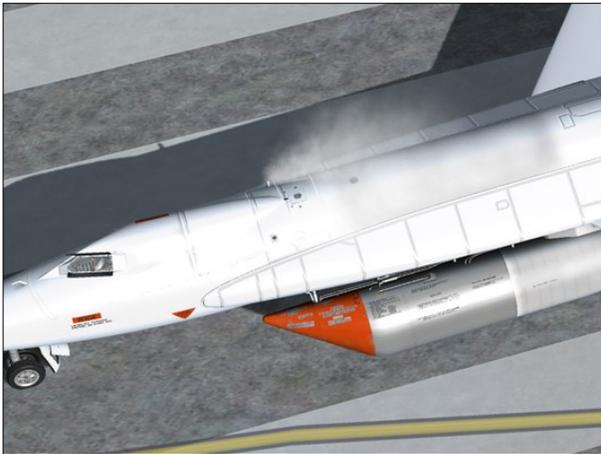
On a real mission, the following procedures are done prior to countdown:

Starting the APUs

1. APU switch No. 1 [17, fig. 5-1] – **ON.** As APU No. 1 comes up to speed, hydraulic pressure will increase and then stabilize at 3000 to 3500 psi.

2. No. 1 generator switch [21, fig. 5-1] – Move No. 1 generator switch momentarily to **RESET**, then to **ON.**

3. No. 1 generator out (amber) light [20, fig. 5-1] – Check **OFF.**

4. APU switch No. 2 [30, fig. 5-1] – **ON.** As APU No. 2 comes up to speed, hydraulic pressure will increase and then stabilize at 3000 to 3500 psi.

5. No. 2 generator switch [26, fig. 5-1] – Move No. 2 generator switch momentarily to **RESET**, then to **ON.**

6. No. 2 generator out (amber) light [25, fig. 5-1] – **Check OFF.**

7. Stable platform power switch [33, fig. 5-1] – **INT (up position).** Power is internal.

8. Service panel external power switch [22, fig. 5-3] – **OFF.** Simulates disconnecting the external power from the external receptacle or from the B-52 carrier.

9. Service panel external power (green) light [23, fig. 5-3] – Check **OFF.**

10. Generator (AC) voltmeter [22, fig. 5-1] – **Check (both pointers, 200 volts, internal).** Power is internal.

11. Hydraulic pressure gauge [13, fig. 5-1] – **Check (both pointers, 3000 to 3500 psi).**

12. DC voltmeter selector switch [13, fig. 5-3] – Check **BUS.**

13. DC voltmeter [12, fig. 5-3] – **Check (28 volts).**

14. Ball nose power switch [6, fig. 5-3] – **ON.**

15. Ball nose test button [7, fig. 5-3] – **Check (normal).**

SAS In-Flight Check

True X-15-type SAS operation is not supported on the current simulation platforms. However, the X-15A-2 SE addon contains a modified SAS panel [48, fig. 5-1] with the simulator's basic autopilot controls for altitude hold, wing leveling, attitude hold and yaw damping modes. Refer to "Stability Augmentation System (SAS)" for a complete description.

The addon avionics must be turned on for the basic autopilot to engage:

1. Radio function selector switch [1, fig. 5-8] – **Check ON, one step right to MAIN TR1, AUX. ADF.** This also turns on the avionics.

Before launch, perform the following functional check of the stability augmentation (basic autopilot) system:

1. SAS (basic autopilot) power switch [78, fig. 5-1] – **SAS ON**. This engages the basic autopilot.

2. SAS yar function switch [8, fig. 5-2] – **STD BY.**

3. SAS pitch, roll and yaw function switches [5, 6, 9, fig. 5-2] – **LO GAIN.** Check that the roll, pitch, and yaw caution (amber) lights [1-3, fig. 5-2] are out.

4. SAS test switch [7, fig. 5-2] – Move SAS test switch to **WORK (NORM)** and check that the SAS pitch, roll and yaw caution (amber) lights blink; then release switch to **OFF (CENTER).**

5. Pitch, roll and yaw function switches [5, 6, 9, fig. 5-2] – **STD BY**, then **LO GAIN.** When the switches are moved to **STD BY**, check that the caution (amber) lights [1-3, fig. 5-2] burn steadily; then move the switches to **LO GAIN**, and check that the caution lights go out.

6. SAS test switch [7, fig. 5-2] – Move SAS test switch to **MON** and check that the SAS pitch, roll and yaw caution (amber) lights

[1-3, fig. 5-2] blink; then release switch to **OFF (CENTER).**

7. Pitch, roll and yaw function switches [5, 6, 9, fig. 5-2] – **STD BY**, then **LO GAIN.** When the switches are moved to **STD BY**, check that the caution (amber) lights [1-3, fig. 5-2] burn steadily; then move the switches to **LO GAIN**, and check that the caution lights go out.

8. Pitch, roll and yaw function switches [5, 6, 9, fig. 5-2] – **STD BY.**

9. SAS power switch [78, fig. 5-1] – **OFF**. This disengages the basic autopilot.

On a real mission, if a SAS malfunction is suspected during flight, the pilot can perform the preceding check at his discretion. The SAS check may be performed on any one function or a combination of pitch, roll, and yaw functions.

How to Engage the Basic Autopilot Modes

You can engage the simulator's basic autopilot modes at any time during flight using the switches on the modified SAS panel [48, fig. 5-1] in the virtual cockpit:

1. Radio function selector switch [1, fig. 5-8] – **Check ON, one step right to MAIN TR1, AUX. ADF** (making sure the avionics is ON).

2. SAS (basic autopilot) power switch [78, fig. 5-1] – **SAS ON**. This engages the basic autopilot.

3. To engage the altitude hold mode: SAS pitch function switch [5, fig. 5-2] – **LO GAIN** or **HI GAIN.**

4. To engage the wing leveler mode: SAS roll function switch [6, fig. 5-2] – **LO GAIN** or **HI GAIN.**

5. To engage the attitude hold mode: SAS yar function switch [8, fig. 5-2] – **LO GAIN** or **HI GAIN.**

6. To engage the yaw damping mode: SAS yaw function switch [9, fig. 5-2] – **LO GAIN**

or **HI GAIN.**

7. To disengage a single mode (or all modes): move the switch(es) to **STD BY.**

8. To disengage the basic autopilot: SAS (basic autopilot) power switch [78, fig. 5-1] – **OFF**.

Known Issue

- We noticed that some of the simulator's basic autopilot functions such as "wing leveler" and "altitude hold", when engaged, induce unwanted oscillations at very high speed and altitude (instead of helping the pilot). Unfortunately, we have no other so-lution at this time but to recommend dis-engaging these functions when such be-havior is encountered until a fix is found. This issue is resolved in Prepar3D® v4.

COUNTDOWN

Operation of X-15 Liquid Nitrogen System

To operate the X-15 airplane liquid nitrogen system at prelaunch, proceed as follows:

1. Ram-air lever [16, fig. 5-3] – **CLOSED**.

2. Cabin source helium shutoff valve switch [11, fig. 5-9] – **CLOSED**.

3. APU cooling switch [17, fig. 5-9] – **NOR-MAL**.

4. Alternate cabin pressurization switch [27,

fig. 5-9] – **ON** (down).

5. Pressure-cooling lever [9, fig. 5-9] – **ON.**

6. Vent suit heater switch [6, fig. 5-4] – **HIGH** or **LOW**.

7. Pressure suit ventilation knob [5, fig. 5-4] – **As required**.

8. X-15 LN$_2$ supply switch (B-52) – Check **CLOSE**. Check with launch operator that switch is at **CLOSE**.

9. Blower switches [10, fig. 5-9] – **BLOWER & LN$_2$**.

10. Windshield heater switches [36, fig. 5-1] – **Check ON.**

Testing the Ball Nose

1. Ball nose power switch [6, fig. 5-3] – **ON.**

2. Ball nose test button [7, fig. 5-3] – **Press (once).**

Depressing the ball nose test button electrical-ly simulates a predetermined airplane attitude. The ball nose should drive to a position that causes the angle-of-attack indicator to show about a 5-degree nose-down indication. The sideslip indicator will also read about a 15-degree sideslip to the left.

When the button is released, the ball nose should drive to the extreme position and ap-pear as a 40-degree nose-up indication on the attitude indicator and a 30-degree sideslip to

the right on the sideslip indicator. This reading should be maintained for 2 to 3 seconds, then the ball nose should resume normal operation, driving rapidly to indicate the actual angle of attack and sideslip of the airplane.

Preparing the External Tanks

1. Fuel selector switch [8, fig. 5-6] – **EXTERNAL.**

2. External tanks jettison auto-manual switch [3, fig. 5-6] – Check **MANUAL.**

3. External tanks jettison buttons [5-6-7, fig. 5-6] – **Check all (normal).**

4. Tank jettison circuit breakers [1-2, fig. 5-6] – **ON/CLOSED (forward).**

5. External tanks jettison safe-arm switch [4, fig. 5-6] – **ARM.**

6. Liquid oxygen top-off flapper valve - **Check.** Obtain confirmation from the launch operator that vaporous oxygen is no longer emitting from the liquid oxygen overboard vent of the B-52 pylon, or from the external tank vent valve. On a real mission, if liquid oxygen continues to emit from the pylon vent, indicating that either the internal or external tanks flapper valve is stuck open, the launch must be aborted.

Propellant Tank Pressurization

When the vent, pressurize, and jettison control lever [11, fig. 5-4] is moved to **PRESSURIZE,** ammonia and liquid oxygen tanks are pressurized and the propellants will be supplied to the engine turbopump. The hydrogen peroxide tank is also pressurized and H_2O_2 will be supplied to the turbopump cut-off valve.

1. Vent, pressurize, and jettison control lever [11, fig. 5-4] – **PRESSURIZE.**

2. Propellant tank pressure gauge [71, fig. 5-1] – **Check ("L" pointer, 45 to 65 psi; "A" pointer, 45 to 65 psi).**

3. External tanks fuel flow indicator [4, fig. 5-1] – **Check (both pointers, about 50% after initial pressurization).**

4. H_2O_2 tank and engine control line pressure gauge [55, fig. 5-1] – **Check ("C" pointer, 575 to 615 psi; "T" pointer, 425 to 475 psi).**

5. Propellant pump inlet pressure gauge [72, fig. 5-1] – **Check ("L" pointer, 45 to 65 psi; "A" pointer, 0 psi).**

Propellant Jettison Tests

Propellant jettison tests will be conducted concurrently on all three systems (liquid oxygen, ammonia and hydrogen peroxide):

1. Vent, pressurize, and jettison control lever [11, fig. 5-4] – **JETTISON.**

2. Jettison stop switches [59, fig. 5-1] – **JETT** for about 3 seconds then **STOP.** In the spot plane exterior view, check for vapor emitting from the jettison ports, at the back of the X-15 aircraft.

3. External tanks fuel flow indicator [31, fig. 4-1] – **Check (both pointers, about 80% during jettison test).**

4. Vent, pressurize, and jettison control lever [5, fig. 4-7] – Return to **PRESSURIZE.**

Note: The liquid oxygen [5, fig. 3-2] and ammonia jettison ports [8, fig. 3-2] are the long tubes protruding at the back of the airplane's side fairings (each side of the engine compartment). The hydrogen peroxide jettison port [10, fig. 3-2] is located inside the lower speed brake compartment.

Proceed to "Launch" or **read "Useful Information Before Launch".**

USEFUL INFORMATION BEFORE LAUNCH

High Altitude Launch

It is possible to simulate a high-altitude launch by using the slew mode commands to reposition the X-15 airplane without flying in real time. A second option is to change the altitude and speed settings in the map window, available from the "World" menu item on the simulator's top menu bar.

When the X-15A-2 SE addon is launched from a high altitude, the following control surface deflections are recommended:

- Horizontal stabilizer:
    - Symmetrical deflection – **0˚**
    - Differential deflection – **0˚**

- Vertical stabilizer – **0˚**

- Speed brakes – **0˚ (in)**

- Flaps – **0˚ (up)**

Takeoff

When taking off from a runway like a conventional aircraft in the simulator, control surfaces must be adjusted to maintain a nose-up climb/pitch angle of about 30 to 45 degrees.

Note: The real X-15 was not designed for a normal takeoff from the ground. Instead, it was dropped from a modified B-52 carrier airplane at an altitude of about 45,000 feet. Be-

cause of the position of the rear landing gear relative to the center of gravity, it is normal for the rear skids to sink slightly into the ground when the airplane takes off, especially if you pull back too much on the center stick.

Takeoff (from the ground) can be accomplished with the X-15A-2 SE addon at around 250 to 280 knots IAS by gently pulling on the joystick. The X-15 has a very low lift-drag ratio at low speed (one that produces little aerodynamic lift).

As soon as the aircraft is airborne, raise the landing gear by pushing the landing gear handle [65, fig. 5-1] on the left wing panel (or by pressing the "**G**" key on your keyboard or the appropriate button on your joystick). When the landing gear is up, the ventral (or the dummy ramjet) [17, 18, fig. 3-2] will appear.

Note: On the real aircraft, the X-15 pilot could not retract the landing gear once it has been deployed because it was locked in place.

Once the rocket engine is ignited, the X-15A-2 will accelerate at a very high rate to high Mach numbers and will reach high altitudes in a matter of seconds. Refer to "Aircraft Reference Information" and "Operating Limitations" for airspeed vs altitude limitations. Use the throttle [12, fig. 5-4] and the speed brakes handles [13, 14, fig. 5-4] to increase or decrease velocity depending on mission objectives and altitude.

If strong movements are applied to the joystick and translated to the control surfaces of

the airplane traveling at several times the speed of sound, the pilot may lose control of the aircraft. During the initial acceleration (zooming) phase, it is recommended to apply only enough movement to the joystick to maintain the correct nose-up pitch angle and a smooth climb.

External Drop Tanks

The X-15A-2 SE addon is equipped with two large external aluminum propellant tanks [28, 29, fig. 3-1] to provide a longer engine run which results in added velocity. In flight, the liquid oxygen and ammonia from the external tanks are transferred, under helium pressure, to their respective internal tanks. Indication of propellant flow from the external tanks is displayed to the pilot on the external tanks fuel flow indicator [4, fig. 5-1] on the main instrument panel.

When the fuel selector switch [8, fig. 5-6], on the external tanks control panel, is set to **EXTERNAL** (propellant system pressurized), a transfer system is activated and the propellant is transferred from the external tanks to the internal tanks. At the end of a preset time period, an intervalometer times out, deactivating the transfer system, and the two external tanks jettison-ready indicator lights [4, fig. 5-1] in the cockpit come **ON**, indicating that the tanks are ready to be released. The propellant feed system automatically shifts to the internal tank feed.

When the external tanks jettison auto-manual switch [3, fig. 5-6] is set to **AUTO** (fuel selector switch at **EXTERNAL** and external tanks jettison safe-arm switch [4, fig. 5-6] to **ARM**), the automatic mode of external tank release system is activated. When the intervalometer times out, the external tanks are automatically released.

Placing the switch to **MANUAL** activates the manual mode of the external tank release system. To release the tanks, the pilot must press one of the external tanks jettison buttons [5-7, fig. 5-6].

Refer to "X-15A-2 Drop Tank System" for more information.

Caution

- The maximum Mach number to be reached by the X-15A-2 with the external tanks attached is **2.6**. The tanks must be released before the airplane reaches this speed.

Ballistic Trajectory

After the external tanks are released, the X-15A-2 quickly accelerates to higher Mach numbers until the pilot shuts down the engine or until a normal "burnout" occurs after the propellants are exhausted. The maximum speed to be attained in the current simulation platforms is approximately Mach 4.65.

In a typical X-15 mission, a burnout will occur after more or less 90 to 150 seconds of XLR-99 engine operation (depending if the external tanks are installed or not).

An engine timer (stopwatch) [11, fig. 5-1] is installed on top of the main panel. The timer is automatically started upon ignition and would later tell the pilot when to shut down the engine, depending on mission objectives (altitude and velocity to be attained).

Make sure the engine timer was **RESET**, if not indicating **0**, before the ignition sequence starts.

Once burnout occurs during a high-altitude mission or when the engine is shut down during a high-speed mission, the X-15A-2 will pursue her ballistic trajectory, sometimes reach-

ing even higher altitudes before commencing her descent. The pilot will then set up the correct angle-of-attack for reentry into the earth's atmosphere (high-altitude mission) and perform a 5G to 7G pullout to level flight at about 70,000 feet, after reentry. The speed brake will be applied to further reduce the speed of the aircraft during the descent.

About High Altitude Flight with the X-15A-2 SE Addon

At the time of publication, ballistic control for rocket airplanes was still not supported in either Microsoft® Flight Simulator X or Lockheed Martin® Prepar3D®. Because aerodynamic control surfaces become less and less effective above about 125,000 feet in the simulator as dynamic pressure decreases, we recommend flying the X-15A-2 addon below 200,000 feet. Surprisingly however, the simulator will still give you limited control at high altitudes, but flying will become more challenging.

Note: The highest altitude attained by the real X-15A-2 rocket plane was 249,000 feet (August 3, 1966).

We found that the best way to complete a ballistic trajectory at high altitude is to level off and maintain heading after the engine is cut off. With the nose slightly down, eventually the aircraft will lose altitude until the control surfaces become effective again.

Navigation

You can use the simulator's Garmin 500 GPS, available from "Views/Instruments" (or "Vehicles/Instrument Panel") in the top menu bar, to track your flight and determine the most appropriate time to shut down the engine before reaching your final destination. You can also use the navigation tools included with the X-15A-2 SE addon:

- ADF/VOR indicators, RMI

- Heading indicator on the attitude indicator

Note: On a real mission, the pilot receives guidance from ground station and from the chase plane pilots to help him navigate.

Ablative Coating

Hypersonic flight generates tremendous amount of heat and a special ablative coating was used to protect the exterior of the X-15A-2 aircraft on special missions. It consisted of the basic Martin MA-25S pink ablator (still being used today on the space shuttle external tank) sealed with the Dow Corning DC90-090 white protective wear layer.

A protective "eyelid" was designed to protect the left canopy window from being smeared with ablator residue during high-speed flight. The eyelid is closed before the acceleration

phase and re-opened before landing. A special handle [6, fig. 4-3], in the cockpit, is used to open or close the eyelid.

Note: If you forgot to close the eyelid before a high speed flight, you can right-click the eyelid handle to clean ablator splatters from the windows.

LAUNCH

Ballistic Control System and Reaction Augmentation System

Since some missions will involve flight at altitudes where control surfaces are ineffective and where ballistic control system operation will be required to maintain airplane attitude, the ballistic control system should be turned on before launch. The reaction augmentation system (RAS) should be turned on as soon as possible after engine burnout.

Note: The ballistic control system rockets were removed from the X-15A-2 with the full white ablative coating because the system was unnecessary for the high-speed flights.

Note: Current flight simulation platforms do not support ballistic control or reaction augmentation systems for rocket airplanes at this time. Consequently, the BCS and RAS switches on the X-15A-2 SE addon main panel do not perform any specific simulator function in this software version, other than being animated to simulate BCS and RAS-related procedures.

To turn on the ballistic control and reaction augmentation systems, proceed as follows:

1. No. 1 ballistic control switch [18, fig. 5-1] – **ON.**

2. No. 2 ballistic control switch [27, fig. 5-1] – **ON.**

3. RAS pitch, roll and yaw function switches [13-15, fig. 5-2] – **ON.**

4. RAS-out (amber) light [12, fig. 5-2] – **OFF.**

5. RAS control indicator (amber) lights [10, fig. 5-4] – **ON.**

Because aerodynamic control surfaces become less and less effective above about 125,000 feet in the simulator as dynamic pressure decreases, we recommend flying the X-15A-2 addon below 200,000 feet. The simulator will still give you limited control at high altitudes, but flying will become more challenging.

Note: The highest altitude attained by the real X-15A-2 rocket plane was 249,000 feet (August 3, 1966).

Preparation for Launch

1. Oxygen selector and gauge (on the left side of the seat) [18, fig. 4-2] – **X-15. Check gauge (3000 to 3200 psi)**.

2. Eyelid handle [6, fig. 4-3] – **AFT** (eyelid closed).

3. Propellant tank pressure gauge [71, fig. 5-1] – **Check ("L" pointer, 45 to 65 psi; "A" pointer, 45 to 65 psi).**

4. External tanks fuel flow indicator [4, fig. 5-1] – **Check (both pointers, about 50%).**

5. H_2O_2 tank and engine control line pressure gauge [55, fig. 5-1] – **Check ("C" pointer, 575 to 615 psi; "T" pointer, 425 to 475 psi).**

6. Propellant pump inlet pressure gauge [72, fig. 5-1] – **Check ("L" pointer, 45 to 65 psi; "A" pointer, 0 psi).**

7. DC voltmeter selector switch [13, fig. 5-3] – **STRAIN GAGE.**

8. Check strain gauge (battery) power supply

(24 volts) on DC voltmeter [12, fig. 5-3].

9. DC voltmeter selector switch [13, fig. 5-3] – **BUS.**

10. Flight controls – **Check.** On a real mission, the X-15 pilot moves all flight controls through allowable travel and receives verbal acknowledgment from the launch operator (in the carrier airplane) and the chase pilots that all control surfaces are operating properly.

11. Engine precool switch [61, fig. 5-1] – **PRECOOL.**

12. Engine prime switch [56, fig. 5-1] – **PRIME.** Move engine prime switch to **PRIME** for one second, then release it and check ignition ready light [2a, fig. 5-1] **ON.** The engine will continue to prime (at high flow rates) until the actual start stops the prime. On the real aircraft, about 30 seconds are required to prime the engine, with the prime valve at high-flow position. A continuous flow overboard of liquid oxygen and ammonia is observed at the back of the aircraft by the launch operator. The prime can be stopped at any time by placing the engine prime switch at **STOP PRIME**. This closes the liquid oxygen and ammonia tank main propellant valves and the H$_2$O$_2$ safety valve.

13. Chamber and stage 2 igniter pressure gauge [50, fig. 5-1] – **Check (both pointers, 0 psi).**

14. H$_2$O$_2$ source and purge pressure gauge [57, fig. 5-1] – **Check (both internal and external tanks, 3000 to 3900 psi).**

15. H$_2$O$_2$ tank and engine control line pressure gauge [55, fig. 5-1] – **Check (both pointers, 575 to 615 psi).**

16. Propellant pump inlet pressure gauge [72, fig. 5-1] – **Check (both pointers, 45 to 65 psi).**

17. Turbopump idle button [54, fig. 5-1] – **Push once.** This will start the engine turbopump and hot exhaust gas will be emitted at the back of the aircraft [2, fig. 3-2].

18. Propellant manifold pressure gauge [51,

fig. 5-1] – **Check (both pointers, 300 to 450 psi).** The manifold pressure will increase during engine operation and will vary according to the movement of the throttle.

19. Move the throttle on your joystick to its maximum (forward) position, then pull the throttle back to its minimum (aft) position. **Make sure that the throttle on your joystick is set to its minimum position.**

20. Telemeter and radar switches [18, 14, fig. 5-3] – **Check ON.**

21. Telemeter commutator motor switch [17, fig. 5-3] – **Check ON.**

22. Communications – **Check.** Check communication with ground station, carrier pilot, and chase pilots.

Launch

1. Ready-to-launch switch [52, fig. 5-1] – **ON.** Verbally check with carrier pilot and launch operator that the Ready-to-launch light is on.

2. Operation of igniter idle is limited to 30 seconds. When 7 seconds remain of the normal igniter idle phase, the no-drop or 23-second (amber) caution light [2b, fig. 5-1] will come **ON.** With the no-drop or 23-second (amber) caution light on, the pilot must terminate the igniter idle phase – by moving the engine prime switch [56, fig. 5-1] to **STOP PRIME** – or continue on to the launch phase. On a real mission, the igniter idle phase must be terminated immediately if the idle-end caution light comes on, as damage to the engine chamber will occur because of insufficient cooling.

3. Igniter idle switch [53, fig. 5-1] – **IGNITER.** When the igniter idle switch is placed to **IGNITER**, the ignition-ready light [2a, fig. 5-1] goes out for 2 seconds while the engine is purged with helium and the igniter spark plugs are energized. When this phase is completed, the ignition-ready light comes on again.

4. Chamber and stage 2 igniter pressure gauge [50, fig. 5-1] – **Check (small point-**

er, 150 psi in about 5 seconds, when stage 2 is ignited). Flames should be observed inside the XLR-99 rocket engine nozzle as stage 1 and stage 2 are ignited. The main chamber and stage 2 igniter pressure will increase during engine operation and will vary according to the movement of the throttle.

Ready to launch!

ABORTED LAUNCH

If for any reason the decision is made to abort the launch after the countdown has started, proceed as follows:

1. Engine prime switch [56, fig. 5-1] – **STOP PRIME.**

2. Igniter idle switch [53, fig. 5-1] – **Check OFF.**

3. Engine precool switch [61, fig. 5-1] – **OFF.**

4. Engine master switch [63, fig. 5-1] – **OFF.**

5. Vent, pressurize, and jettison control lever [11, fig. 5-4] – **VENT.**

6. External power switch [22, fig. 5-3] on the service panel – **ON.** Electrical power will be supplied from an external source.

7. No.1 and No. 2 generator switches [21, 26, fig. 5-1] – **OFF.** Check that both No. 1 and No. 2 generator-off (amber) lights [20, 25, fig. 5-1] come ON.

8. APU switches [17, 30, fig. 5-1] – **OFF.**

9. Ventral arming switch [35, fig. 5-1] – **DE-ARM.**

ENGINE START

After release from the "carrier airplane" or when ready to take off from the runway, proceed as follows:

1. Parking/differential brake (if applied, take-off only) – **RELEASED ("." key).**

2. Throttle [12, fig. 5-4] – **START (click and then move inboard to 50%).** Throttle must be moved to 50% by the time the idle-end (amber) caution light [2b, fig. 5-1] comes on. Note that combustion in the main thrust chamber of the XLR-99 engine will start almost instantaneously when the throttle lever is moved from OFF to START 50%.

3. As soon as the aircraft is airborne, raise the landing gear by pushing the landing gear handle [65, fig. 5-1] on the left wing panel (or by pressing the "**G**" key on your keyboard or the appropriate button on your joystick).

4. Chamber and stage 2 igniter pressure gauge [50, fig. 5-1] – **Check (large pointer, 335 to 600 psi within 2 seconds, depending on throttle position; small pointer 350 to 630 psi, depending on throttle position).**

5. Propellant manifold pressure gauge [51, fig. 5-1] – **Check ("L" pointer, 455 to 980 psi; "A" pointer, 510 to 1155 psi).**

6. Propellant (helium) source pressure gauge [69, fig. 5-1] – **Check (both internal and external tanks, 3300 to 3900 psi).**

7. H_2O_2 source and purge (helium) pressure gauge [57, fig. 5-1] – **Check (both internal**

and external tanks, 3300 to 3900 psi).

8. Propellant tank pressure gauge [71, fig. 5-1] – **Check ("L" pointer, 45 to 65 psi; "A" pointer, 45 to 65 psi).**

9. H_2O_2 tank and engine control line pressure gauge [55, fig. 5-1] – **Check (both pointers, 575 to 615 psi).**

10. External tanks fuel flow indicator on the main instrument panel [4, fig. 5-1] – **50% to 100%.**

Engine Thrust Control

Engine thrust is controlled by movement of the throttle between 50% and 100% thrust. Engine response to throttle movement is very rapid, 50% to 100% in approximately 1.5 seconds.

Normal Indications during Start

When the main thrust chamber is fired, the following indications will be evident:

- Turbine whine;

- Turbine exhaust steam will be seen at the back of the aircraft;

- Liquid oxygen and ammonia will automatically stop bleeding overboard (as observed during prime);

- Liquid oxygen and ammonia manifold pressure will rise to rated values;

- Igniters will be operating;

- Chamber pressure will rise to a point where the igniters cease firing and chamber pressure will be shown on the indicator gauge;

- Airplane propellants will be consumed at a very high rate;

- Chamber pressure will reach rated values;

- Thrust chamber will emit a great deal of noise;

- Flames and exhaust gases (smoke, steam) will be seen at the back of the airplane.

NORMAL OPERATING CONDITIONS

The following conditions accompany normal XLR-99 rocket engine operation:

1. Propellant source pressure gauge [69, fig. 5-1] – **(both internal and external tanks) 3200-3800 psi, gradually decreasing.**

2. H_2O_2 source and purge pressure gauge [57, fig. 5-1] – **(both internal and external tanks) 3000 psi, gradually decreasing.**

3. Propellant tank pressure gauge [71, fig. 5-1] – **45 to 53 psi (both pointers).**

4. Propellant pump inlet pressure gauge [72, fig. 5-1] – **"L" pointer, 40 to 70 psi; "A" pointer, 40 to 55 psi.**

5. APU H_2O_2 tank pressure gauge [44, fig. 5-1] – **550 to 610 psi (both pointers).**

6. Auxiliary pneumatic and control (helium) pressure gauge [21, fig. 5-3] – **Check (3000 to 3700 psi).**

7. Cabin helium source pressure gauge [40, fig. 5-1] – **1000 to 3400 psi.**

8. Hydraulic pressure gauge [13, fig. 5-1] – **2900 to 3400 psi (both pointers).**

9. APU bearing temperature gauge [43, fig. 5-1] – **80˚ C to 130˚ C (both pointers).**

10. Mixing chamber temperature gauge [42, fig. 5-1] – **-45˚ C to -35˚ C (both pointers).**

11. Generator (AC) voltmeter [22, fig. 5-1] – **195 to 205 volts.**

12. H_2O_2 tank and engine control line pressure gauge [55, fig. 5-1] – **"C" pointer, 575 to 600 psi; "T" pointer, 565 to 600 psi.**

13. Propellant manifold pressure gauge [51, fig. 5-1] – **"L" pointer, 440 to 1050 psi; "A" pointer, 495 to 1150 psi.**

14. Chamber and stage 2 igniter pressure gauge [50, fig. 5-1] – **large pointer, 345 to 600 psi; small pointer, 350 to 630 psi.**

EXTERNAL TANKS RELEASE

The external tanks must be released <u>before the X-15A-2 reaches Mach 2.6</u>.

1. Fuel selector switch [8, fig. 5-6] – **Check EXTERNAL.**

2. External tanks jettison auto-manual switch [3, fig. 5-6] – Check **MANUAL.**

3. External tanks jettison buttons [5-6-7, fig. 5-6] – **Check all (normal).**

4. Tank jettison circuit breakers [1-2, fig. 5-6] – **Check ON/CLOSED (forward).**

5. External tanks jettison safe-arm switch [4, fig. 5-6] – **Check ARM.**

Warning

▪ On a real mission, use the external tanks jettison full (or partially full) button to release full (or partially full) tanks for successful tank separation. **Do not use the external tanks jettison empty button to release a full tank, as serious damage to the tanks and airplane will result.**

Note: In the simulator, the tanks will not jettison if the wrong button is used.

To manually release the external tanks, proceed as follows:

▪ If the two external tanks jettison-ready indicator lights [4, fig. 5-1] are **ON** and the

tanks are <u>empty</u>, press the gray external tanks jettison empty button [7, fig. 5-6] to release the tanks.

Or

▪ If the two external tanks jettison-ready indicator lights are **OFF** and the tanks are <u>not empty but not full</u>, press the black external tanks jettison partially full button [6, fig. 5-6] to release the tanks.

Or

▪ If the two external tanks jettison-ready indicator lights are **OFF** and the tanks are <u>full</u>, press the red external tanks jettison full button [5, fig. 5-6] to release the tanks.

ENGINE BURNOUT

Propellant exhaustion (burnout) will result in the following:

▪ Ammonia or oxygen manifold pressure drops, with consequent shutdown (of the engine) by low manifold safety circuit;

▪ Pump cavitates, with consequent overspeed (pump and engine) cut-off.

SHUTDOWN PROCEDURE

To shut down the engine, proceed as follows:

▪ **Retard throttle** [12, fig. 5-4] to **50%**: then move throttle outboard to **OFF** (<u>right-click</u> the throttle handle after it is moved to 50%).

▪ Engine prime switch [56, fig. 5-1] – **STOP PRIME**.

After Engine Shutdown

1. Igniter idle switch [53, fig. 5-1] – **Check OFF.**

2. Engine prime switch [56, fig. 5-1] – **STOP PRIME.**

3. Engine precool switch [61, fig. 5-1] – **OFF.**

4. Engine master switch [63, fig. 5-1] – **OFF.**

5. Vent, pressurize, and jettison control lever [11, fig. 5-4] – **VENT.**

DESCENT

1. Head restraint [8, fig. 4-3] – **EXTENDED (down position).**

2. If necessary, use the speed brakes [3, 34, fig. 3-1] to reduce the speed of the aircraft during descent. To open or close the speed brakes, **press " / "** on your keyboard as desired (the speed brakes can

also be opened, closed and adjusted by using the speed brake handles [13, 14, fig. 5-4] on the left console).

3. **Pull the joystick SMOOTHLY** to perform a 5-G to 7-G pullout to level flight at about 70,000 to 60,000 feet, after reentry.

Caution

▪ The speed brakes on the X-15 aircraft were not designed for use as a low-speed drag device. Their design function was to provide the necessary drag conditions for control of the airplane at supersonic speeds and relatively high altitudes.

▪ The X-15 possesses a very low lift-drag ratio. After the engine is shut down, the aircraft would come down fast and steep. Because of the high rate of descent and the reduced stability at low Mach numbers, the speed brakes are not to be used at full deflection below Mach 1.5.

On selected aircraft:

1. No. 1 ballistic control switch [18, fig. 5-1] – **OFF.**

2. No. 2 ballistic control switch [27, fig. 5-1] – **OFF.**

FUEL JETTISON

1. Head restraint [8, fig. 4-3] – **STOWED (up position).**

2. Eyelid handle [6, fig. 4-3] – **FORWARD (eyelid open).**

3. Retractable pitot handle [80, fig. 5-1] – **PULL (OUT).**

While approaching the landing site, the remaining propellants must be jettisoned from the X-15 to minimize fire or explosion hazard upon landing and to lower the weight of the aircraft. To jettison the remaining propellants from the X-15A-2 airplane before landing or after an aborted launch, proceed as follows:

1. Propellant source pressure gauge [69, fig.

5-1] – **Check.**

2. Vent, pressurize, and jettison control lever [11, fig. 5-4] – **JETTISON.** Fuel jettison will be conducted concurrently on all three systems (liquid oxygen, ammonia and hydrogen peroxide).

3. Jettison stop switches [59, fig. 5-1] – **JETT.** In the spot plane exterior view, check for vapor emitting from the three jettison ports, at the back of the X-15 aircraft. Propellant jettison can also be monitored on the X-15A-2 SE system monitor panel.

4. Vent, pressurize, and jettison control lever [11, fig. 5-4] – After propellants are jettisoned, move control lever to **VENT.**

Note: The liquid oxygen [5, fig. 3-2] and ammonia jettison ports [8, fig. 3-2] are the long tubes protruding at the back of the airplane's side fairings (each side of the engine compartment). The hydrogen peroxide jettison port [10, fig. 3-2] is located inside the lower speed brake compartment.

BEFORE LANDING

When altitude is under 17,000 feet, proceed as follows:

1. Vent, pressurize, and jettison control lever [11, fig. 5-4] – **PRESSURIZE.** This is to prevent sand and dust from entering the airplane propellant system during landing.

2. Check all controls and instruments for landing.

LANDING

See figure on the next page for the recommended landing patterns and procedures.

Caution

- Glide distance may be varied with Mach to achieve the desired distance. During gliding flight, high rates of descent will be experienced; speed brakes will increase the rate of descent considerably and should only be used at speeds above Mach 1.5. Speeds above Mach 1.5 will usually occur at high altitude and will allow sufficient time to reduce the rate of descent before entering the landing phase. In case of either inability to retract the speed brakes or inadvertent extension of the landing gear before entering the landing pattern, certain precautions must be observed.

Dummy Ramjet (or Ventral) Jettison

Under normal flight conditions, the dummy ramjet (or ventral) should not be jettisoned except during landing approach. To provide ground clearance for the landing gear, the dummy ramjet (or ventral) must be jettisoned before landing. The dummy ramjet (or ventral) should be jettisoned at an altitude of about 5000 feet and at a minimum of 1500 feet above the ground.

When the altimeter indicates 5000 feet, proceed as follows:

1. Ventral arming switch [35, fig. 5-1] –
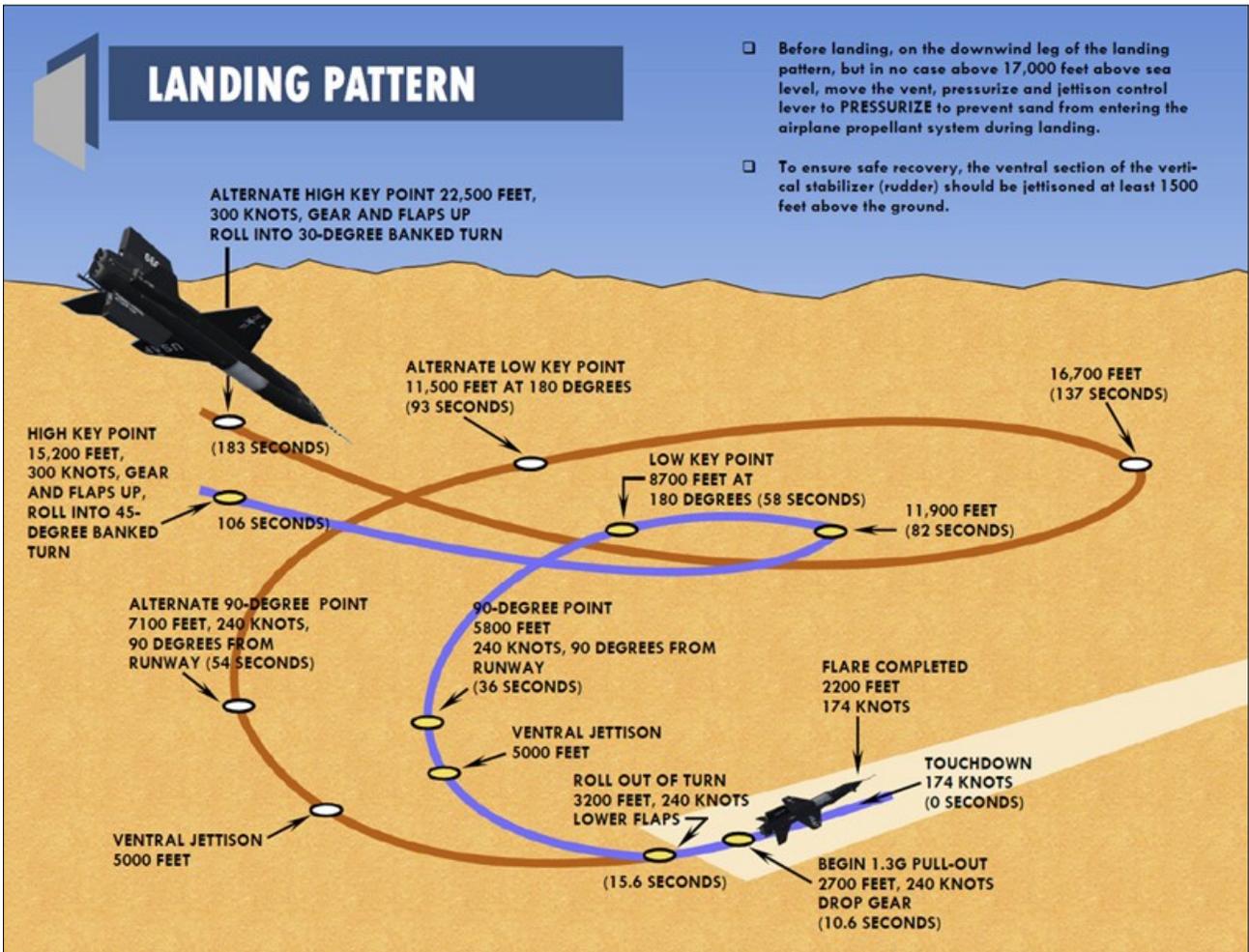
LANDING PATTERN

❏ Before landing, on the downwind leg of the landing pattern, but in no case above 17,000 feet above sea level, move the vent, pressurize and jettison control lever to PRESSURIZE to prevent sand from entering the airplane propellant system during landing.

❏ To ensure safe recovery, the ventral section of the vertical stabilizer (rudder) should be jettisoned at least 1500 feet above the ground.

ALTERNATE HIGH KEY POINT 22,500 FEET, 300 KNOTS, GEAR AND FLAPS UP ROLL INTO 30-DEGREE BANKED TURN

ALTERNATE LOW KEY POINT 11,500 FEET AT 180 DEGREES (93 SECONDS)

16,700 FEET (137 SECONDS)

HIGH KEY POINT 15,200 FEET, 300 KNOTS, GEAR AND FLAPS UP, ROLL INTO 45-DEGREE BANKED TURN

(183 SECONDS)

LOW KEY POINT 8700 FEET AT 180 DEGREES (58 SECONDS)

11,900 FEET (82 SECONDS)

106 SECONDS)

ALTERNATE 90-DEGREE POINT 7100 FEET, 240 KNOTS, 90 DEGREES FROM RUNWAY (54 SECONDS)

90-DEGREE POINT 5800 FEET 240 KNOTS, 90 DEGREES FROM RUNWAY (36 SECONDS)

FLARE COMPLETED 2200 FEET 174 KNOTS

VENTRAL JETTISON 5000 FEET

ROLL OUT OF TURN 3200 FEET, 240 KNOTS LOWER FLAPS

TOUCHDOWN 174 KNOTS (0 SECONDS)

VENTRAL JETTISON 5000 FEET

(15.6 SECONDS)

BEGIN 1.3G PULL-OUT 2700 FEET, 240 KNOTS DROP GEAR (10.6 SECONDS)

Check ARM.

2. Ventral jettison button [67, fig. 5-1] – **Push (once).**

Pushing the ventral jettison button actually fires explosive bolts to release the dummy ramjet (or ventral). Note that the dummy ramjet (or ventral) is also jettisoned automatically when the landing gear is deployed.

Lowering the Flaps

Flaps are lowered at about 3200 feet. To lower the flaps, move the wing flap switch [9, fig. 5-4], on the left white control box, to **DWN** or use the "**F8**" key on your keyboard (or the appropriate button on your joystick).

Extending the Landing Gear

The landing gear is extended at about 2700 feet. To extend the landing gear, pull (drag) the landing gear handle out [65, fig. 5-1] on the left wing panel or use the "**G**" key on your keyboard.

Note: The landing gear is configured so it (and the aircraft) sits properly on the ground on most hard surfaces such as a concrete runway or a dry lakebed. However, it is normal for the landing gear to be partially buried into the ground or even to "float" above it if you land

the aircraft on a rough, soft (sandy) or uneven terrain, for example, after an emergency landing somewhere in the desert. This also depends on the resolution of the mesh on which it sits. This is a terrain issue and not an addon issue.

AFTER LANDING

After landing, as soon as the airplane stops, proceed as follows:

1. Parking brake – **APPLIED ("CTRL+." keys).**

2. Canopy – Open (**SHIFT-E** on your keyboard or click the internal canopy handle [1, fig. 5-5]).

3. Ram-air lever [16, fig. 5-3] – **Check CLOSED.**

4. Wing flap switch [9, fig. 5-4] – **UP.**

5. SAS/RAS function switches [5, 6, 8, 9, 13-15, fig. 5-2] – **All STD BY or OFF.**

6. Ventral arming switch [35, fig. 5-1] – **DE-ARM.**

7. Generator switches [21, 26, fig. 5-1] – **Both OFF.**

8. APU switches [17, 30, fig. 5-1] – **Both OFF.**

9. Speed brake levers [13-14, fig. 5-4] – **Full aft position.** Before operating the speed brakes, be sure the fuselage rear section around the speed brakes is clear, because the brakes operate rapidly and forcefully and could injure any personnel near the brakes.

10. Vent, pressurize, and jettison control lever [11, fig. 5-4] – **VENT.**

11. Center stick [8, fig. 4-1] (joystick) – **Full forward.**

12. Rudder pedals [11, fig. 4-1] – **Actuate.** Deplete hydraulic pressure by actuating rudder pedals.

BEFORE LEAVING THE AIRPLANE

On a real mission, before leaving the airplane, complete the required airplane form.

Verify the following cockpit control positions:

1. Parking brake (sim) – **Check APPLIED ("CTRL+." keys).**

Left console, seat and wing panel:

1. Trim control switch [1, fig. 5-4] – **Check CENTER.**

2. Intercom switch [2, fig. 5-4] – **Check OFF.**

3. Face mask heater switch [3, fig. 5-4] – **OFF.**

4. Jettison trim switch [4, fig. 5-4] – **Check OFF.**

5. Vent suit heater switch [6, fig. 5-4] – **OFF.**

6. Pressure suit ventilation knob [4, fig. 5-4] – **CLOSED.**

7. Radio function selector switch [1, fig. 5-8] – **OFF.**

8. Tank jettison circuit breakers [1-2, fig. 5-6] – **OFF/OPEN (aft).**

9. External tanks jettison auto-manual switch [3, fig. 5-6] – **Check MANUAL.**

10. External tanks jettison safe-arm switch [4, fig. 5-6] – **SAFE (guard down).**

11. External tanks jettison buttons [5-6-7, fig. 5-6] – **Check all (normal).**

12. Fuel selector switch [8, fig. 5-6] – **Check EXTERNAL.**

13. Speed brake handles [13-14, fig. 5-4] – **Check AFT.**

14. Wing flap switch [9, fig. 5-4] – **Check UP.**

15. Alternate SAS switch [16, fig. 5-4] – **Check OFF (guard down).**

16. RAS (amber) indicator lights [10, fig. 5-4] – **Check all OFF.**

17. Vent, pressurize, and jettison control lever [11, fig. 5-4] – **Check VENT.**

18. Throttle [12, fig. 5-4] – **Check OFF**.

19. SAS (land) disengage switch [77, fig. 5-1] – **OFF.**

20. SAS (autopilot) power switch [78, fig. 5-1] – **OFF.**

21. Jettison stop switches [59, fig. 5-1] – **Check STOP.**

22. Auxiliary launch switch [60, fig. 5-1] – **OFF (guard down).**

23. Ventral jettison button [67, fig. 5-1] – **Check (normal).**

24. Landing gear handle [65, fig. 5-1] – **Check OUT.**

25. Oxygen selector and gauge (on the left side of the seat) [18, fig. 4-2] – **OFF.**

Main instrument panel:

1. Ignition-ready (green) light [2a, fig. 5-1] – **Check OFF.**

2. 23-second caution (amber) light [2b, fig. 5-1] – **Check OFF.**

3. Idle-end caution (amber) light [2c, fig. 5-1] – **Check OFF.**

4. Valve malfunction caution (amber) light [2d, fig. 5-1] – **Check OFF.**

5. Stage 2 igniter malfunction caution (amber) light [2e, fig. 5-1] – **Check OFF.**

6. Turbopump overspeed caution (amber) light [2f, fig. 5-1] – **Check OFF.**

7. Engine vibration malfunction caution (amber) light [2g, fig. 5-1] – **Check OFF.**

8. Fire-warning (red) light [47, fig. 5-1] – **Check OFF.**

9. Helium release selector switch [1, fig. 5-1] – **Check OFF.**

10. Propellant emergency pressurization switch [68, fig. 5-1] – **Check OFF.**

11. Ammonia tank pressure-low caution (amber) light [66, fig. 5-1] – **Check OFF.**

12. Liquid oxygen tank pressure-low caution (amber) light [70, fig. 5-1] – **Check OFF.**

13. Engine master switch [63, fig. 5-1] – **Check OFF.**

14. Engine reset button [62, fig. 5-1] – **Check (normal).**

15. Engine precool switch [61, fig. 5-1] – **Check OFF.**

16. Engine prime switch [56, fig. 5-1] – **Check STOP PRIME (DOWN).**

17. Turbopump idle button [54, fig. 5-1] – **Check (normal).**

18. Igniter idle switch [53, fig. 5-1] – **Check OFF.**

19. Fuel line low caution (amber) light [64, fig. 5-1] – **Check OFF.**

20. H_2O_2 compartment-hot caution (amber) light [58, fig. 5-1] – **Check OFF.**

21. Pilot's O_2 low caution (amber) light [6, fig. 5-1] – **Check OFF.**

22. External tanks jettison ready indicator (amber) lights [4, fig. 5-1] – **Check both OFF.**

23. SAS pitch function switch [5, fig. 5-2] – **Check STD BY.**

24. SAS roll function switch [6, fig. 5-2] – **Check STD BY.**

25. SAS test switch [7, fig. 5-2] – **Check OFF (middle).**

26. SAS yar function switch [8, fig. 5-2] – **Check STD BY.**

27. SAS yaw function switch [9, fig. 5-2] – **Check STD BY.**

28. SAS caution (amber) lights (four) [1-4, fig. 5-2] – **Check all OFF.**

29. Alt SAS switch [11, fig. 5-2] – **Check OFF.**

30. Alt SAS on (green) light [10, fig. 5-2] – **Check OFF.**

31. RAS pitch function switch [13, fig. 5-2] – **Check OFF.**

32. RAS roll function switch [14, fig. 5-2] – **Check OFF.**

33. RAS yaw function switch [15, fig. 5-2] – **Check OFF.**

34. RAS auto cutoff switch [16, fig. 5-2] – **Check OFF.**

35. RAS out (amber) light [12, fig. 5-2] – **Check OFF.**

36. Retractable pitot handle [80, fig. 5-1] – **IN.**

37. Skylight hatch open (amber) light [73, fig. 5-1] – **Check OFF.**

38. Automatic ignition sequence start button [76, fig. 5-1] – **Check (normal).**

39. Ready-to-launch switch [52, fig. 5-1] – **OFF.**

40. Engine timer [11, fig. 5-1] – Note time. **RE-SET.**

Main instrument panel (electrical, hydraulic, and cockpit):

1. Emergency battery switch [23, fig. 5-1] – **Check OFF (guard down).**

2. Hydrogen peroxide transfer switch [24, fig. 5-1] – **Check OFF.**

3. No. 1 generator-out (amber) light [20, fig. 5-1] – **Check OFF.**

4. No. 2 generator-out (amber) light [25, fig. 5-1] – **Check OFF.**

5. No. 1 and No. 2 generator switches [21, 26, fig. 5-1] – **Check OFF.**

6. APU No. 1 switch [17, fig. 5-1] – **Check OFF.**

7. APU No. 1 warning and caution lights [28, 29, 31, fig. 5-1] – **Check OFF.**

8. No. 1 ballistic control switch [18, fig. 5-1] – **Check OFF.**

9. No. 2 ballistic control switch [27, fig. 5-1] – **Check OFF.**

10. APU No. 2 warning and caution lights [28, 29, 31, fig. 5-1] – **Check OFF.**

11. APU No. 2 switch [30, fig. 5-1] – **Check OFF.**

12. Cabin pressure altimeter [41, fig. 5-1] – **Check.**

Center pedestal (service panel):

1. External power switch [22, fig. 5-3] – **OFF.**

2. External power (green) light [23, fig. 5-3] – **Check OFF.**

3. External tank option switch [26, fig. 5-3] – **ON.**

4. Unlimited fuel option switch [27, fig. 5-3] – **ON** or **OFF** (your choice).

Center pedestal (research instrumentation panel):

1. Data switch [1, fig. 5-3] – **OFF.**

2. Data (amber) light [2, fig. 5-3] – **Check OFF.**

3. Calibrate button and (green) light [3, fig. 5-3] – **Check (normal).**

4. Physiological instrumentation switch [4, fig. 5-3] – **OFF.**

5. Blood pressure switch [5, fig. 5-3] – **OFF.**

6. Ball nose power switch [6, fig. 5-3] – **OFF.**

7. Ball nose test button [7, fig. 5-3] – **Check (normal).**

8. Telemeter master power switch [18, fig. 5-3] – **OFF.**

9. Telemeter commutator motor switch [17, fig. 5-3] – **OFF.**

10. Telemeter FM switch [8, fig. 5-3] – **OFF.**

11. Skylight hatch switch [19, fig. 5-3] – **Check OFF** (skylight hatch closed).

12. Star tracker switch [20, fig. 5-3] – **Check OFF.**

13. Instrumentation master power switch [15, fig. 5-3] – **OFF.**

14. Radar beacon switch [14, fig. 5-3] – **OFF.**

15. Stable platform instrument switch [10, fig. 5-3] – **OFF.**

16. Tape recorder power switch [9, fig. 5-3] – **OFF.**

17. Cockpit ram-air knob [11, fig. 5-3] – **Check OFF (in)**

18. Ram-air lever [16, fig. 5-3] – **CLOSED.**

19. DC voltmeter selector switch [13, fig. 5-3] – **OFF.**

Right console and wing panel:

1. Canopy emergency release handle [32, fig. 5-1] – **IN.**

2. Stable platform switch [33, fig. 5-1] – **OFF.**

3. Nose ballistic rocket heater switch [34, fig. 5-1] – **OFF.**

4. Ventral arming switch [35, fig. 5-1] – **Check DE-ARM (guard down).**

5. Cockpit lighting switch [39, fig. 5-1] – **OFF.**

6. Indicator, caution, and warning light test switch [38, fig. 5-1] – **Check OFF.**

7. Fire-warning light test button [37, fig. 5-1] – **Check (normal).**

8. Windshield heater switches (two) [36, fig. 5-1] – **OFF.**

9. Canopy internal handle [1, fig. 5-5] – **Check AFT and UNLOCKED (canopy open)**.

10. Windshield antifogging (yellow) handle [2, fig. 4-3] – **Check CLOSED (vertical) position.**

11. Windshield purge (gray) handle [3, fig. 4-3] – **Check CLOSED (vertical) position.**

12. All breakers on the breaker panel – **Check PUSHED IN (closed).**

13. Pressure-cooling lever [9, fig. 5-9] – **OFF (aft position).**

14. Blower switches [10, fig. 5-9] – **OFF (middle position).**

15. Cabin helium source shutoff valve switch [11, fig. 5-9] – **OFF.**

16. APU nitrogen cooling switch [17, fig. 5-9] – **OFF.**

17. Alternate cabin pressurization switch [27, fig. 5-9] – **OFF.**

Congratulations on your new high-speed (or high-altitude) record!

The following "quick-start" procedures can be followed to start the engine and fly the X-15A-2 SE addon without going through the complete check list and procedures presented in the previous section. We recommend that you use these procedures only if you are familiar with both your simulation platform and the X-15A-2 SE addon.

We assume that you have already started your simulation platform, created a flight and configured the simulator with the optimal settings for your system. We also assume that the engine is shut down and that there are no unwanted special visual effects around the X-15A-2 aircraft, and that you are in the virtual cockpit view ("**F9**").

Make sure the parking brake is applied **("CTRL+." keys)**. You can also hide the center stick for a better access to the center pedestal controls by clicking the center stick leather boot [9, fig. 4-1].

Quick-Start Procedures

Note: Each step in the check list below is numbered in the image above (green circles). Steps 1 and 34 are not shown (parking brake set/released).

1. Parking brake – **Check APPLIED ("CTRL+." keys).**

2. Eyelid handle [6, fig. 4-3] – **AFT (eyelid closed).**

3. External power switch [22, fig. 5-3] – **ON.**

4. Express fill button [24, fig. 5-3] – **Push once.**

5. External tanks option switch [26, fig. 5-3] – **Check INSTALLED.**

6. Unlimited fuel option switch [27, fig. 5-3] – **ON.**

7. Instrumentation master power switch [15, fig. 5-3] – **ON.**

8. Stable platform instrument power switch [10, fig. 5-3] – **ON.**

9. DC voltmeter switch [13, fig. 5-3] – **BUS.**

10. Ball nose power switch [6, fig. 5-3] – **ON.**

11. Ram-air lever [16, fig. 5-3] - **CLOSED**.

12. Radio function selector switch [1, fig. 5-8] – **Turn ON, one step right to MAIN TR1, AUX. ADF.**

13. APU cooling switch [17, fig. 5-9] - **NOR-MAL**.

14. Pressure-cooling lever [9, fig. 5-9] - **ON**.

15. Blower switches [10, fig. 5-9] - **BLOWER & LN$_2$**.

16. Windshield heater switches [36, fig. 5-1] – **ON.**

17. No. 1 APU switch [17, fig. 5-1] – **ON.**

18. No. 2 APU switch [30, fig. 5-1] – **ON.**

19. No. 1 generator switch [21, fig. 5-1] – **ON.**

20. No. 2 generator switch [26, fig. 5-1] – **ON.**

21. External power switch [22, fig. 5-3] – **OFF.**

22. Stable platform switch [33, fig. 5-1] – **INTERNAL (up position).**

23. Fuel selector switch [8, fig. 5-6] – **Check EXTERNAL.**

24. External tanks jettison auto-manual switch [3, fig. 5-6] – **Check MANUAL.**

25. Tank jettison circuit breakers [1-2, fig. 5-6] – **ON/CLOSED (forward).**

26. External tanks jettison safe-arm switch [4, fig. 5-6] – **ARM.**

27. Vent, pressurize, and jettison control lever [11, fig. 5-4] – **PRESSURIZE. Wait 5 seconds.**

28. Engine master switch [63, fig. 5-1] – **ARM.**

29. Engine turbopump reset switch [62, fig. 5-1] – **PUSH once.**

30. Engine precool switch [61, fig. 5-1] – **PRE-COOL.**

31. Engine prime switch [56, fig. 5-1] – **PRIME.** Move engine prime switch to **PRIME**, then release it. **Wait 5 seconds.**

32. Engine turbopump idle switch [54, fig. 5-1] – **PUSH once. Wait 5 seconds.**

33. Engine igniter idle switch [53, fig. 5-1] – **ON. Wait 10 seconds.**

34. Parking brake – **RELEASED ("." key).**

35. Throttle [12, fig. 5-4] – **START (click and then move inboard to about 75%).** Throttle must be moved to START 50% by the time the idle-end (amber) caution light [2b, fig. 5-1] comes on.

36. As soon as the aircraft is airborne, raise the landing gear by pushing the landing gear handle [65, fig. 5-1] on the left wing panel (or by pressing the "**G**" key on your keyboard or the appropriate button on your joystick).

Most emergency procedures in this section apply to a real X-15 mission. However, some procedures may also be performed in the simulator.

ENGINE FAILURE

Engine Failure

Failure of rocket engines is, as a rule, the result of thrust chamber burnout. Specific information on this type engine failure is given in "Thrust Chamber Burnout" (below). If engine failure is due to malfunction of the fuel control system or improper operating technique, a start can usually be made to restore engine operation, provided time and altitude permit. However, if the failure is an obvious failure within the engine, a start should not be attempted.

Malfunction Shutdowns

Automatic malfunction shutdowns can occur during the engine start phase or during actual engine operation. The design of the malfunction shutdown circuits is such that restart attempts can safely be made after a malfunction shutdown. This is because a restart will not be successful if the malfunction which caused the original shutdown has not been corrected.

Malfunction shutdowns which can occur during the start phase are those due to main or first stage propellant valve malfunction, stage 2 ignition malfunction, or engine turbopump overspeed. Malfunction shutdowns which can occur during engine operation are those caused by engine turbopump overspeed or excessive engine vibration.

If a malfunction shutdown occurs, attempt a restart. Refer to "Engine Restart" below.

Causes of Pump Cavitation

Failure to sufficiently prime the liquid oxygen pump discharge line to the engine, excessive heat absorption by the liquid oxygen together with excessive vapor pressure (normal liquid oxygen tank vapor pressure after tank has been filled is 20 to 24 psi), or insufficient liquid oxygen tank pressure can cause pump cavitation. When liquid oxygen pump cavitation occurs, the overspeeding turbopump is stopped by the overspeed protection system. When an engine is shut down by the turbopump overspeed protection system, the turbopump overspeed caution light is illuminated.

Indications of Pump Cavitation

Cavitation is accompanied by the following indications:

- Increase of pitch in whine of turbine

- No ignition

- No flame from chamber

- No noise from chamber

- No thrust chamber pressure

- Very high momentary fuel manifold pressure

- Very low liquid oxygen manifold pressure

- Turbopump stops and overspeed indicator

light, in cockpit, comes on

Engine Restart

If the engine has failed or has been shut down automatically and it is determined that a restart is feasible, proceed as follows:

1. Throttle [12, fig. 5-4] – **OFF.**

2. Engine reset button [62, fig. 5-1] – **Push.**

3. Engine prime switch [56, fig. 5-1] – PRIME. Move engine prime switch to **PRIME** for one second and check ignition-ready light [2a, fig. 5-1] **ON**. Approximately 30 seconds is required to prime, with prime valve at high-flow orifice position.

4. Throttle [12, fig. 5-4] – **START,** then **AS DESIRED.**

Thrust Chamber Burnout

Thrust chamber burnout can be determined by various engine indications which can be verified by the X-15 pilot or the chase pilots. These indications are as follows:

- Fuel manifold pressure [51, fig. 5-1] drops below oxygen manifold pressure, accompanying cylinder "groaning"

- Engine emits loud ("hog-calling") scream or howl

- Yellow streak of flame or yellow bushy flame is evident

- Chamber pressure [50, fig. 5-1] drops while manifold pressures are within specified range

CAPTIVE OPERATION EMERGENCIES

Before Takeoff

In case a "FIRE" warning [47, fig. 5-1], "APU COMPT HOT" [29, fig. 5-1], or "H_2O_2 HOT" [28, fig. 5-1] light comes on before takeoff, notify the carrier pilot that an X-15 emergency is in progress (refer to "Fire or Explosion" below),

and prepare to abandon the airplane.

In-Flight

In case of an emergency during captive flight, the carrier pilot must verify the emergency and ascertain the danger to the crew. It will be the carrier pilot's responsibility to initiate one or more of the following emergency procedures:

- X-15 emergency launch (refer to "Emergency Launch" below)

- X-15 pilot ejection (refer to "Ejection" below)

- Abort mission or launch (refer to "Aborted Launch")

The five basic rules covering selection of the proper procedure are as follows:

1. X-15 hazardous to B-52 – **Launch X-15 (this may be preceded by X-15 pilot ejection if the X-15 is hazardous to the X-15 pilot).**

2. B-52 hazardous to X-15 below critical altitude – **Eject X-15 pilot and B-52 crew.**

3. B-52 hazardous to X-15 above critical altitude – **Launch X-15 and eject B-52 crew.**

4. X-15 emergency not immediately hazardous – **Return to base for landing.**

5. B-52 emergency not immediately hazardous - **Return to base for landing.**

Emergency Launch

In case of an emergency aboard the B-52 which endangers the X-15 or in case of an emergency in the X-15 which would endanger the B-52, it is possible to emergency-launch the X-15. If time and altitude permit a launching of this type, proceed as follows:

1. Oxygen selector switch [18, fig. 4-2] – **Switch from carrier supply to X-15 supply.**

2. Ventral arming switch [35, fig. 5-1] – **ARM.**

3. Emergency battery switch [23, fig. 5-1] –
   ON. If the APUs are not operating at the
   time of emergency launch, the emergency
   battery must be ON to enable APU start.

4. No. 1 and No. 2 APU switches [17, 30, fig.
   5-1] – **ON.** Monitor hydraulic guages [13,
   fig. 5-1] for both systems as APUs come up
   to speed.

5. No. 1 and No. 2 generator switches [21,
   26, fig. 5-1] – To **RESET** momentarily,
   then to **ON.**

6. Ram-air lever [16, fig. 5-3] – **CLOSED.**

7. Cabin source helium shutoff valve switch
   [12, fig. 5-9] – **ON, then OFF.**

8. Pressure-cooling lever [12, fig. 5-9] – **ON.**

9. Blower switches [12, fig. 5-9] – **ON.**

10. Instrumentation master switch [15, fig. 5-
    3] – **ON.**

11. Stable platform instruments switch [15,
    fig. 5-3] – **ON.**

12. Stable platform power switch [33, fig. 5-1]
    – **INT.**

If engine start is desired:

1. Engine master switch [63, fig. 5-1] – **ON.**

2. Engine reset button [62, fig. 5-1] – **Push.**

3. Engine precool switch [61, fig. 5-1] – **ON.**

4. Engine prime switch [56, fig. 5-1] – **PRIME.**

5. Ready-to-launch switch [52, fig. 5-1] – **ON.**

6. Vent, pressurization, and jettison lever
   [11, fig. 5-4] – **PRESSURIZE.**

7. Engine turbopump idle button [54, fig. 5-
   1] – **Push.**

8. Engine igniter idle switch [53, fig. 5-1] –
   IGNITER.

9. Throttle [12, fig. 5-4] – **START, then AS
   DESIRED.**

If no engine start is desired:

1. Vent, pressurization, and jettison lever
   [11, fig. 5-4] – **JETTISON.**

FIRE OR EXPLOSION

In case of a fire or explosion, the procedures
given in the following paragraphs should be
accomplished. However, an important factor in
determining the course of action to be taken
depends on the effect the fire or explosion has
on the flight control systems. Since a failure of
the aerodynamic flight control system could
occur as a result of the fire or explosion, a
careful check of the aerodynamic system
should be made to determine whether a safe
landing can be made.

Engine Fire

If the fire-warning light [47, fig. 5-1] comes on
or if there are other indications of fire, pro-
ceed as follows:

1. Helium release selector switch [1, fig. 5-1]
   – **Check AUTO.** With the helium release
   selector switch at AUTO when the fire-
   warning system is activated, the engine is
   automatically shut down and the engine
   compartment purged. If automatic shut-
   down is successful, proceed to step 3.

However, if the engine fails to shut down, proceed to step 2.

2. Shut down engine:

   a) Engine master switch [63, fig. 5-1] – **OFF.** Moving the engine master switch to **OFF** purges the engine with helium for approximately 17 seconds.

   b) Helium release selector switch [1, fig. 5-1] – **ON.**

3. Throttle [12, fig. 5-4] – **OFF.**

4. Igniter idle switch [53, fig. 5-1] – **OFF.**

5. If fire cannot be confirmed, land as soon as possible. If fire cannot be confirmed or if it goes out, establish controllability and jettison propellants en route to the nearest available base where a landing can be made. Obtain assistance from chase pilot if possible. Reconfirm controllability before descent below safe ejection altitude.

6. If fire is confirmed or if aerodynamic control is lost – **Eject.**

Electrical Fire

In case of an electrical fire, attempt to isolate fire by moving circuit breakers off one at a time. Allow sufficient time for the indication of fire to cease. When source of fire is found, leave the affected circuit de-energized, and restore power to remaining circuits.

H_2O_2 Compartment Overheat

If the "H_2O_2 COMP HOT" [58, fig. 5-1] light comes on, immediately notify the carrier pilot that an X-15 emergency is in progress. Then prepare for an emergency launch (refer to "Emergency Launch"), in case an emergency launch becomes necessary.

APU H_2O_2 Overheat

If the APU "H_2O_2 HOT" [28, fig. 5-1] light comes on, immediately notify the carrier pilot that an X-15 emergency is in progress. Determine

which APU system is overheated and proceed as follows:

1. APU switch – **OFF.** The APU system that is overheated must be shut down.

2. APU switch – **JETT.** Maximum time for jettison is approximately 27 seconds. Launch operator and chase pilot will monitor jettison pattern.

3. Prepare for emergency launch. Refer to "Emergency Launch".

APU H_2O_2 Low Caution

If the "H_2O_2 LOW" [31, fig. 5-1] caution light comes on, notify the carrier pilot that an X-15 emergency is in progress. Shut down affected APU and prepare for an aborted launch.

1. APU switch – **OFF.** The affected APU system must be shut down.

2. APU switch – **JETT.** Maximum time for jettison is approximately 27 seconds. Launch operator and chase pilot will monitor jettison pattern.

3. Prepare for an aborted launch.

APU Compartment Overheat

If the "APU COMP HOT" [29, fig. 5-1] light comes on, immediately notify the carrier pilot that an X-15 emergency is in progress. Determine which APU system is overheated and proceed as follows:

1. APU switch – **OFF.** The APU system that is overheated must be shut down.

2. APU switch – **JETT.** Maximum time for jettison is approximately 27 seconds. Launch operator and chase pilot will monitor jettison pattern.

3. Prepare for emergency launch. Refer to "Emergency Launch".

EJECTION

Seat Ejection

Note: The ejection seat in the X-15A-2 addon has some animated features. However, it cannot eject from the cockpit in this software version.

Escape from the airplane in flight must be made by means of the ejection seat. Ejection from 200 knots at zero altitude to any speed and altitude possible by the carrier airplane can be made while the airplane is attached to the carrier airplane. After launch, ejection is possible up to Mach 4 and any altitude up to 120,000 feet . Refer to "Ejection Seat" for more information.

Ventral Jettison System Failure

The ventral [17-18, fig. 3-2] is jettisoned when the ventral jettison button [67, fig. 5-1] is pushed. If the ventral fails to jettison, as verified by the chase pilot, pulling the landing gear lowering lanyard [65, fig. 5-1] should jettison the ventral. Receive verbal confirmation from the chase pilot that the ventral jettisoned.

Emergency Entrance

Emergency entrance into the cockpit is made by manually opening the canopy, or if necessary, jettisoning it. In either case, the ejection seat must first be disarmed if the ejection handles [10, fig. 4-2] are raised.

FUEL SYSTEM FAILURE

Airplane Fuel System Failure

If propellant system pressurization is lost, a caution light ("LOX" or "NH_3" [70, 66, fig. 5-1]) will come on. System pressure can be restored for continued low thrust engine operation or propellant jettisoning by moving the propellant emergency pressurization switch [70, 66, fig. 5-1] toward the illuminated light. The emergency pressurization helium supply will provide sufficient emergency pressure for one tank only.

Note: Failure of the propellant pressurization system is not simulated in this software version.

Engine Fuel System Failure

Failure of the engine fuel system would be the result of an engine turbopump allure. Refer to "Turbopump Failure Durlng Flight" above.

Fuel Line Pressure Low

In the event of a low fuel line pressure caution light [64, 66, fig. 5-1] during flight (above 40,000 feet), proceed as follows:

1. Throttle [12, fig. 5-4] – **Reduce.** Reduce engine thrust setting as necessary to maintain fuel inlet pressure [72, fig. 5-1] at 30 psi. If pressure returns to normal, full throttle operation can be resumed.

2. **Continue operation, or shut down.** Operation can be continued at 50% thrust setting if fuel inlet pressure remains above 20 psi. If fuel inlet pressure cannot be maintained above 20 psi, even at 50% thrust, shut down engine immediately, provided a safe landing can be made. An engine restart is not to be attempted unless pilot or airplane safety necessitates resumption of power.

Turbopump Failure During Flight

A turbopump failure will in most cases be caused by pump cavitation, or incorrect governor supply pressure. The possibility of a mechanical malfunction of the relatively simple turbopump assembly is not considered likely. Turbopump failure or shutoff, caused by the overspeed caution light [2f, fig. 5-1] coming on. If the overspeed caution light comes on, the engine may be restarted in the following manner:

1. Throttle [12, fig. 5-4] – **OFF.**

2. Engine reset button [62, fig. 5-1] – **Push.**

3. Engine precool switch [56, fig. 5-1] – **PRE-COOL.**

4. Engine prime switch [56, fig. 5-1] – **PRIME.** Move engine prime switch to **PRIME** for one second and check ignition-ready light [2a, fig. 5-1] **ON.**

5. Throttle [12, fig. 5-4] – **START, then AS DESIRED.**

Propellant Jettisoning

In an emergency where the engine propellants must be jettisoned, recheck jettison test switches [59, fig. 5-1] at **JETT**; then move the vent, pressurization, and jettison lever [11, fig. 5-4] to **JETTISON**, which allows the propellants to flow overboard. Approximate time required to jettison a full propellant load is about 120 seconds.

APU SYSTEM FAILURE

The dual APUs provided allow normal operation as long as one APU is operating. However, certain equipment not required for safe flight will be lost.

Note: The SAS emergency hydraulic system automatically provides hydraulic power for the SAS pitch and roll servos in the event of a No. 2 hydraulic system failure.

Loss of APU No. 1
Results in complete loss of ball nose and SAS yaw

Mission abort may be required

Loss of APU No. 1 and APU No. 2
Results in complete loss of all hydraulic power

Emergency battery to attempt to restart APU

Loss of APU No. 1
Results in complete loss of all electrical power

If restart fails, ejection is mandatory

ELECTRICAL POWER SUPPLY SYSTEM FAILURE

Complete Electrical Failure

If complete electrical failure occurs because of loss of both generators, the APUs will continue to operate. If the APU's are not operating, the emergency battery must be energized to start the APUs. With both generators failed, the airplane can be landed. If complete electrical failure occurs because of failure of both APUs, the emergency battery switch [23, fig. 5-1] must be turned **ON**, so that the APUs can be restarted. If the APUs cannot be restarted, ejection is mandatory.

Generator Failure

If either APU or generator fails and cannot be reset, certain missions may be flown, dependent on ground control. If a failure of this type should occur, proceed as follows:

1. No. 1 or No. 2 blower switch [10, fig. 5-9] – **OFF.** Operation of one equipment compartment blower at a time will substantially reduce the electrical load; however, operation of only one blower will appreciably shorten its life.

2. Vent suit heater switch [6, fig. 5-4] – **OFF.**

3. Pressure suit ventilation knob [5, fig. 5-4] – **OFF.**

As soon as the unique research portion of the flight is over, continue with the following steps:

1. Instrumentation master switch [15, fig. 5-3] – **OFF.**

2. Radar beacon switch [14, fig. 5-3] – **OFF.**

3. Telemeter master, commutator and FM switches [18, 17, 8, fig. 5-3] – **OFF.**

4. No. 1 and No. 2 blower switches [10, fig. 5-9] – **BLOWER & LN2.**

Generator Reset Procedure (APUs Running)

When a generator irregularity occurs, as shown by a generator failure light [20, 25, fig. 5-1] coming on, try to bring the generator back as follows:

1. Generator switch [21, 26, fig. 5-1] – **RESET momentarily**; then **ON.** Generator-out light should go out and remain out if failure was temporary.

2. Generator-out light [20, 25, fig. 5-1] – Check **OFF.**

Emergency Battery Operation

If failure of both APUs or both generators occurs, the emergency battery must be energized to power the battery bus. The battery bus supplies power for restarting the APUs or to control the APUs:

1. Emergency battery switch [23, fig. 5-1] – **ON.**

HYDRAULIC SYSTEM FAILURE

Hydraulic System Failure

No emergency system is provided for the hydraulically operated aerodynamic flight control system, speed brakes, and wing flaps. However, this airplane has an SAS emergency hydraulic system which automatically provides hydraulic power to the SAS pitch and roll servos in the event of a No. 2 hydraulic system failure.

Flight Control Hydraulic System Failure

If failure of one flight control hydraulic system occurs, the other system assumes the entire load of aerodynamic flight control system operation. However, under such a condition, available control surface hinge moments will be one half their design value, because of reduction of hydraulic flow. Refer to "Aerodynamic Flight Control System" for more information.

Artificial-Feel System Failure

The artificial-feel system failure can be indicated by a lightening of stick forces (resulting in overcontrol), lack of trim response, and poor stick-centering characteristics. If failure of flight control artificial feel is encountered, proceed as follows:

1. Airspeed – **Reduce.** Reduction of airspeed may relieve severe oscillations of the airplane.

2. If control cannot be maintained – **Eject.** Ejection is recommended if control cannot be maintained. If partial control is available, thoroughly check flight characteristics before descending below safe ejection altitude.

Trim System Failure

If the trim system fails in either extreme-travel position, the maximum force required by the pilot to move the control surface to the opposite extreme is not beyond physical capabilities. If the pitch trim knob [4, fig. 5-5] fails, the trim system can be controlled by the alternate trim switch on the center stick [8, fig. 4-1]. The trim control switch [1, fig. 5-4] must be moved to **ALTERNATE** before the alternate trim switch is operable.

SAS FAILURE

The stability augmentation system provides aerodynamic damping on ail axes of the airplane. If any axis of the SAS fails, control can be maintained by the pilot.

Note: True X-15-type SAS operation is not supported on the current simulation platforms. However, the X-15A-2 SE addon contains a modified SAS panel [48, fig. 5-1] with the basic autopilot controls for altitude hold, wing leveling, attitude hold and yaw damping modes.

BALLISTIC CONTROL SYSTEM FAILURE

Failure of one system does not affect the operation of the other system, which is adequate to maintain attitude control. However, control will be at a reduced rate. Refer to "Ballistic Control System".

Note: At the time of publication, ballistic control for rocket airplanes was still not supported in either Microsoft® Flight Simulator X or Lockheed Martin® Prepar3D®. Consequently, the BCS and RAS controls and switches in the X-15A-2 SE do not perform any simulator function in this software version, other than being animated to simulate BCS and RAS-related procedures.

MAXIMUM GLIDE AND FORCED LANDING

Glide distance may be varied with Mach to achieve the desired distance. During gliding flight, high rates of descent will be experienced; speed brakes will increase the rate of descent considerably and should only be used at speeds above Mach 1.5. Speeds above Mach 1.5 will usually occur at high altitude and will allow sufficient time to reduce the rate of descent before entering the landing phase.

In case of either inability to retract the speed brakes or inadvertent extension of the landing gear before entering the landing pattern, certain precautions must be observed.

X-15A-2 SPECIFIC (DROP TANKS ATTACHED)

Emergency Launch

Revise the "Emergency Launch" procedure as follows:

1. External tanks jettison auto-manual switch [3, fig. 5-6] – **MANUAL.**

2. Tank jettison circuit breakers [1-2, fig. 5-6] – **ON/CLOSED (forward).**

3. External tanks jettison safe-arm switch [4, fig. 5-6] – **ARM.**

On a real mission, use the external tanks jettison full (or partially full) button to release full (or partially full) tanks for successful tank separation. **Do not use the external tanks jettison empty button to release a full tank, as serious damage to the tanks and airplane will result.**

Note: In the simulator, the tanks will not jettison if the wrong button is used.

To manually release the external tanks, proceed as follows:

- If the two external tanks jettison-ready indicator lights [4, fig. 5-1] are **ON** and the tanks are <u>empty</u>, press the gray external tanks jettison empty button [7, fig. 5-6] to release the tanks.

Or

- If the two external tanks jettison-ready indicator lights are **OFF** and the tanks are <u>not empty but not full</u>, press the black external tanks jettison partially full button [6, fig. 5-6] to release the tanks.

Or

- If the two external tanks jettison-ready indicator lights are **OFF** and the tanks are <u>full</u>, press the red external tanks jettison full button [5, fig. 5-6] to release the tanks.

Caution

- If drop tanks are to be released while full, they must be released after launch at approximately 10 degrees airplane angle of attack and before engine start. Both external tanks release simultaneously and propellant feed transfers automatically to internal tanks.

Engine Fire or Explosion

Revise the "Engine Fire" procedure as follows:

If fire cannot be confirmed, land as soon as possible. If fire cannot be confirmed, or if it goes out, establish controllability, release external tanks (see above), and jettison propel-

lants en route to the nearest available base where a landing can be made. Obtain assistance from chase pilot if possible. Reconfirm controllability before descent below safe ejection altitude.

Propellant Jettisoning

Captive Flight

Because of placement of the ports in the external tanks, approximately 5500 pounds of propellants will be trapped in the external tanks when the propellants are jettisoned during captive flight. This data applies only for level, unaccelerated flight. If propellant jettison is accomplished at a nose-down attitude, additional propellants will be trapped.

After Launch

In the event of an engine failure, the loss of thrust will result in the external tank propellants being forced to the forward end of the tanks. Under this condition, a large amount of the propellants in the external tanks cannot be jettisoned. Therefore, the external tanks must be released (see above) before an attempt is made to jettison internal system propellants.

APPENDICES

INSTRUMENT READINGS AFTER SERVICING

The following conditions should be observed after servicing (external tanks attached):

System Monitor Panel

1. Ammonia tanks – **Internal tanks, 1445 gallons; external tanks 1053 gallons.**

2. Liquid oxygen tanks – **Internal tanks, 1017 gallons; external tanks, 770 gallons.**

3. Turbopump hydrogen peroxide (H_2O_2) tanks – **118 gallons.**

4. Solid fuel (X-15AD-4 airplane only) – **Both boosters, 100 percent.**

5. Propellant source (helium) tanks – **Both internal and external tanks, 3200-3800 psi.**

6. Engine and propellant control source (helium) tanks – **Both internal and external tanks, 3200-3800 psi.**

7. Auxiliary pneumatic and control (helium) tank – **3200-3800 psi.**

8. APU H_2O_2 tanks – **60-75 gallons, both pointers.**

9. APU source (helium) tanks – **3200-3800 psi, both pointers.**

10. Liquid N_2 tank – **25-30 gallons.**

11. Cabin helium tank – **3200-3800 psi.**

12. Pilot's O_2 (seat) cylinders – **3000-3200 psi.**

Main Instrument Panel

1. Propellant source pressure gauge [69, fig. 5-1] – **Both internal and external tanks, 3200-3800 psi.**

2. H_2O_2 source pressure gauge [57, fig. 5-1] – **Both internal and external tanks, 3200-3800 psi.**

3. External tanks fuel flow indicator 4, fig. 5-1] – **0%.**

4. APU source pressure gauge [45, fig. 5-1] – **3200-3800 psi, both pointers.**

5. Cabin helium source pressure gauge [40, fig. 5-1] – **1000 to 3400 psi.**

6. Generator (AC) voltmeter [22, fig. 5-1] – **200 volts, both pointers (external power).**

7. H_2O_2 tank and engine control pressure gauge [55, fig. 5-1] – **"T" pointer, 0 psi; "C" pointer, 575-600 psi.**

INSTRUMENT READINGS AFTER PROPELLANT SYSTEM PRESSURIZATION

The following conditions should be observed after propellant tanks are pressurized with APUs in operation, but before the engine is fired:

System Monitor Panel

1. Ammonia tanks – **Internal tanks, 1445 gallons; external tanks 1053 gallons (approx.).**

2. Liquid oxygen tanks – **Internal tanks, 1017 gallons; external tanks, 770 gallons (approx.).**

3. Turbopump hydrogen peroxide (H_2O_2) tanks – **118 gallons.**

4. Solid fuel (X-15AD-4 airplane only) – **Both boosters, 100 percent.**

5. Propellant source (helium) tanks – **Both internal and external tanks, 3200-3800 psi.**

6. Engine and propellant control source (helium) tanks – **Both internal and external tanks, 3200-3800 psi.**

7. Auxiliary pneumatic and control (helium) tank – **3200-3800 psi.**

8. APU H_2O_2 tanks – **60-75 gallons, both pointers, gradually decreasing.**

9. APU source (helium) tanks – **3200-3800 psi, both pointers, gradually decreasing.**

10. Liquid N_2 tank – **25-30 gallons, gradually decreasing.**

11. Cabin helium tank – **3200-3800 psi, gradually decreasing.**

12. Pilot's O_2 (seat) cylinders – **3000-3200 psi.**

Main Instrument Panel

1. Propellant source pressure gauge [69, fig. 5-1] – **Both internal and external tanks, 3200-3800 psi.**

2. H_2O_2 source pressure gauge [57, fig. 5-1] – **Both internal and external tanks, 3200-3800 psi.**

3. Propellant tank pressure gauge [71, fig. 5-1] – **45 to 53 psi (both pointers).**

4. External tanks fuel flow indicator [4, fig. 5-1] – **50%.**

5. Propellant pump inlet pressure gauge [72, fig. 5-1] – **"L" pointer, 40 to 70 psi; "A" pointer, 40 to 55 psi.**

6. APU source pressure gauge [45, fig. 5-1] – **3200-3800 psi, both pointers, gradually decreasing.**

7. APU H_2O_2 tank pressure gauge [44, fig. 5-1] – **550 to 610 psi (both pointers), gradually decreasing.**

8. Cabin helium source pressure gauge [40, fig. 5-1] – **1000 to 3400 psi.**

9. Hydraulic pressure gauge [13, fig. 5-1] – **2900 to 3400 psi (both pointers).**

10. Mixing chamber temperature gauge [42, fig. 5-1] – **-45° C to -35° C (both pointers).**

11. Generator (AC) voltmeter [22, fig. 5-1] – **195 to 205 volts, both pointers (internal power if generators are ON).**

12. APU bearing temperature gauge [43, fig. 5-1] – **80° C to 130° C (both pointers), gradually increasing.**

13. H_2O_2 tank and engine control pressure gauge [55, fig. 5-1] – **"T" pointer, 0 psi; "C" pointer, 575-600 psi.**

INSTRUMENT READINGS IN FLIGHT

The following conditions accompany normal rocket engine operation (APUs and engine operating, unlimited fuel option switch [27, fig. 5-3] at **OFF**):

System Monitor Panel

1. Ammonia tanks – **Internal tanks, 1445 gallons; external tanks 1053 gallons (approx.), gradually decreasing.**

2. Liquid oxygen tanks – **Internal tanks, 1017 gallons; external tanks, 770 gallons (approx.), gradually decreasing.**

3. Turbopump hydrogen peroxide (H_2O_2) tanks – **118 gallons, gradually decreas-**

ing.

4. Solid fuel (X-15AD-4 airplane only) – **Both boosters, 100 percent, gradually decreasing.**

5. Propellant source (helium) tanks – **Both internal and external tanks, 3200-3800 psi, gradually decreasing.**

6. Engine and propellant control source (helium) tanks – **Both internal and external tanks, 3200-3800 psi, gradually decreasing.**

7. Auxiliary pneumatic and control (helium) tank – **3200-3800 psi.**

8. APU H_2O_2 tanks – **60-75 gallons, both pointers, gradually decreasing.**

9. APU source (helium) tanks – **3200-3800 psi, both pointers, gradually decreasing.**

10. Liquid N_2 tank – **25-30 gallons, gradually decreasing.**

11. Cabin helium tank – **3200-3800 psi, gradually decreasing.**

12. Pilot's O_2 (seat) cylinders – **2500-3000 psi, gradually decreasing.**

Main Instrument Panel

1. Propellant source pressure gauge [69, fig. 5-1] – **Both internal and external tanks, 3200-3800 psi and gradually decreasing** (if the unlimited fuel option switch is at **OFF**).

2. H_2O_2 source pressure gauge [57, fig. 5-1] – **Both internal and external tanks, 3200-3800 psi and gradually decreasing** (if the unlimited fuel option switch is at **OFF**).

3. Propellant tank pressure gauge [71, fig. 5-1] – **45 to 53 psi (both pointers).**

4. External tanks fuel flow indicator [4, fig. 5-1] – **50% to 100%.**

5. Propellant pump inlet pressure gauge [72, fig. 5-1] – **"L" pointer, 40 to 70 psi; "A" pointer, 40 to 55 psi.**

6. APU source pressure gauge [45, fig. 5-1] – **3200-3800 psi, both pointers, gradually decreasing.**

7. APU H_2O_2 tank pressure gauge [44, fig. 5-1] – **550 to 610 psi (both pointers), gradually decreasing.**

8. Cabin helium source pressure gauge [40, fig. 5-1] – **1000 to 3400 psi.**

9. Hydraulic pressure gauge [13, fig. 5-1] – **2900 to 3400 psi (both pointers).**

10. Mixing chamber temperature gauge [42, fig. 5-1] – **-45° C to -35° C (both pointers).**

11. Generator (AC) voltmeter [22, fig. 5-1] – **195 to 205 volts, both pointers (internal power if generators are ON).**

12. APU bearing temperature gauge [43, fig. 5-1] – **80° C to 130° C (both pointers), gradually increasing.**

13. H_2O_2 tank and engine control pressure gauge [55, fig. 5-1] – **"T" pointer, 0 psi; "C" pointer, 575-600 psi.**

14. Propellant manifold pressure gauge [51, fig. 5-1] – **"L" pointer, 440 to 1050 psi; "A" pointer, 495 to 1150 psi.**

15. Chamber and stage 2 igniter pressure gauge [50, fig. 5-1] – **long pointer, 345 to 600 psi; short pointer, 350 to 630 psi.**

THE SAVED FLIGHTS

The X-15A-2 SE v2.0 addon includes six saved flights (two for each X-15A-2 SE model) that can be used as "templates" for starting a new X-15 flight in the simulator. A seventh saved flight is included for the purpose of inspecting the aircraft on the ground.

Loading a saved flight has the advantage of presetting all X-15A-2 internal systems to OFF and preventing the rocket plane from moving by itself on the runway at the beginning of a flight because the engine was running in the previous flight with the parking brake not set.

It is also easier to prepare the X-15A-2 for takeoff or to simulate a high altitude launch by loading one of the saved flights.

Refer to "Loading or Creating a Flight" for more information.

Loading a Saved Flight

The X-15A-2 SE saved flights can be loaded from the "Load Flight" (or "Load Scenario") page in FSX or Prepar3D®.

You can access the "Load Flight" (or "Load Scenario") page from the "Flights" (or "Scenario") menu item in the top menu bar in FSX or Prepar3D®. Select **LOAD...**

1.   Select a flight with the prefix "X-15A-2 SE".
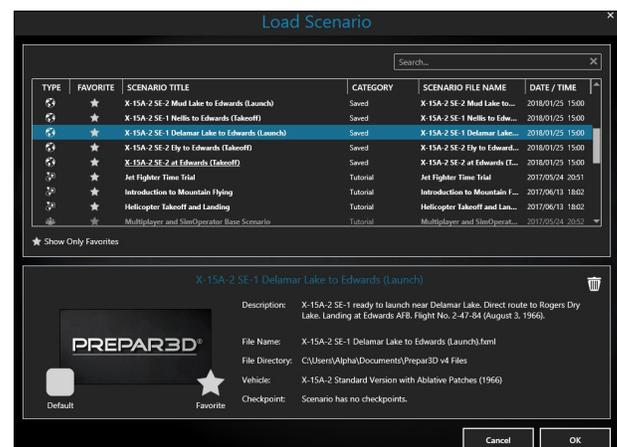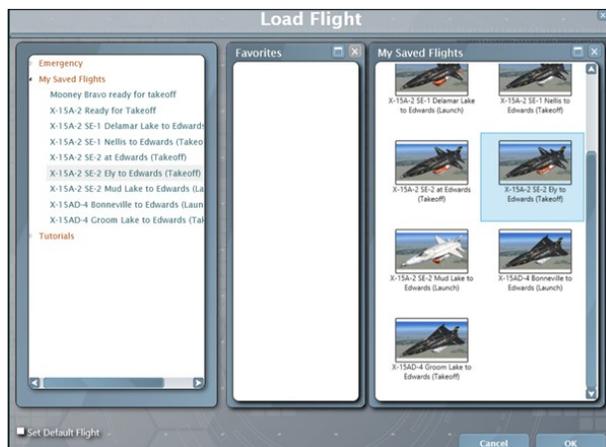
2.   Click **FLY NOW!** (or **OK**) to close the "Load Flight" (or "Load Scenario") page and start a new flight.

You can also access the "Load Flight" page from the "Free Flight" page in FSX:

1.   Just above the aircraft preview window, select **LOAD...**

2.   Select a flight with the prefix "X-15A-2 SE".

3.   Click **FLY NOW!** to close the "Load Flight" page and start a new flight.

After the flight is loaded in the simulator, you can proceed with the normal or quick-start procedures, or click the automatic ignition sequence start button [76, fig. 5-1] on the main

instrument panel) to start the engine.

Note: The X-15A-2 SE saved flights are installed in your "C:\Users*your name\simulator name* Files" folder, on your computer. Refer to "Installing your Addon".

Known Issue (FSX in another language than English)

- If you are using Flight Simulator X in another language than English, you will need to manually move the saved flights from the "C:\Users*your name*\Documents\Flight Simulator X Files" folder to your "C:\Users*your name*\Documents*Flight Simulator X Files in your language*" folder. This is because Flight Simulator X changes the name of your saved flight folder, depending on your language. For example, while the folder name "Flight Simulator X Files" is used in English, it becomes "Fichiers Flight Simulator X" in French. The installer cannot detect the language of your simulation platform so you will have to copy or move the saved flight files manually. This is not an issue in Prepar3D®.

Note to FSX: Steam® Edition Users

- The X-15A-2 SE addon is fully compatible with Flight Simulator X: Steam® Edition. A special installer is available from our "Downloads" section (free for registered users). Please use this installer for installing your X-15A-2 SE addon in FSX: Steam® Edition. If not, the saved flights will

be missing (see below).

- Please note that FSX: Steam® Edition is installed in a different way to the boxed version and occupies a different location on your computer. With the standard installer for FSX, you will need to copy the saved flights from the "C:\Users\your name\Documents\Flight Simulator X Files" folder to your "C:\Users\your name\Documents\Flight Simulator X - Steam Edition Files" folder. This is because FSX: Steam® Edition uses a different folder to store your saved flights.

- For these reasons, we recommend using the special installer for FSX: Steam® Edition that is available from our "Downloads" section.

Important

- You must be in the virtual cockpit view to operate this addon. The X-15A-2 SE has no 2D panels. If your addon appears to have no virtual cockpit, make sure you have selected the **VIRTUAL COCKPIT** view in the simulator, not the (2D) cockpit view. The virtual cockpit is available from the "Views" menu item on your simulation platform's top menu bar or by pressing the "**F9**" key on your keyboard. You can also cycle forward or backward the different views with both the "**S**" key and the "**A**" key or you can select the virtual cockpit as the default cockpit view when configuring your simulation platform.

- **Do not use "CTRL+E" to start the engine!** Use the automatic ignition sequence start button [76, fig. 5-1] instead. Read more.

There are two categories of X-15A-2 SE flights: the "takeoff" flights and the (high altitude) "launch" flights. Each category contains fictitious flights and flights that are based on actual X-15A-2 historical missions.

High Altitude Launch Flights

After a high-altitude "launch" flight is loaded and the X-15 is dropped at around 45,000 feet and 0.8 Mach, click the automatic ignition se-

quence start button [76, fig. 5-1] or proceed with the quick-start procedures to start the engine and fly the X-15 to the edge of space! Follow your heading, complete your ballistic trajectory, shut off the engine and glide your way back to Rogers Dry Lake, near Edwards AFB (KEDW).

By default, the automatic ignition sequence turns ON the unlimited fuel option switch [27, fig. 5-3] on the service panel. If you prefer a more realistic X-15 flight with a limited engine burn time, **turn OFF** the unlimited fuel option switch before the automatic ignition sequence turns ON the engine master switch [63, fig. 5-1]. Once the engine master switch is turned ON, the unlimited fuel option switch cannot be changed.

There are three high-altitude "launch" flights included with the X-15A-2 SE addon. These flights enable the X-15A-2 to be launched at a high altitude over a dry lake that was used for high-altitude launches during the actual X-15 program:

- **X-15A-2 SE-1 Delamar Lake to Edwards (Launch)**
  X-15A-2 SE-1 ready to launch near Delamar Lake. Direct route to Rogers Dry Lake. Landing at Edwards AFB. Flight No. 2-47-84 (August 3, 1966).

- **X-15A-2 SE-2 Mud Lake to Edwards (Launch)**
  X-15A-2 SE-2 ready to launch near Mud Lake. Direct route to Rogers Dry Lake. Landing at Edwards AFB. Flight No. 2-53-97 (October 3, 1967).

- **X-15AD-4 Bonneville to Edwards (Launch)**
  X-15AD-4 ready to launch near Bonneville

Salt Flats. Direct route to Rogers Dry Lake. Landing at Edwards AFB. Fictitious flight (September 23, 1969).

Takeoff Flights

Unlike the real X-15 that was designed to be launched at a high altitude from a B-52, the X-15A-2 SE addon can also take off from a runway like any other aircraft in the simulator. Yes, we know, it's not realistic! However, it's a simulation and taking off from the ground is rather fun and is something the real-world X-15 pilots could not do!

Note: The real X-15 was not designed for a normal takeoff from the ground. Because of the position of the rear landing gear relative to the center of gravity, it is normal for the rear skids to sink slightly into the ground when the airplane takes off, especially if you pull back too much on the center stick.

After a "takeoff" flight is loaded, click the automatic ignition sequence start button [76, fig. 5-1] or proceed with the standard or quick-start procedures to start the engine and take off from the runway.

There are four "takeoff" flights included with the X-15A-2 SE addon. Two fictitious flights enable the X-15A-2 to take off from runways located near dry lakes where actual high altitude launches were performed during the real X-15 program. A third flight will allow the fictitious X-15AD-4 to take off from the main runway at Area 51 (Groom Lake). And a fourth flight is provided for inspecting the X-15A-2 on the main runway at Edwards AFB where the X-15 program took place:

- **X-15A-2 SE-1 Nellis to Edwards (Takeoff)**
  X-15A-2 SE-1 ready for takeoff at Nellis AFB. Direct route to Rogers Dry Lake. Landing at Edwards AFB. Fictitious flight (May 18, 1966).

- **X-15A-2 SE-2 Ely to Edwards (Takeoff)**
  X-15A-2 SE-2 ready for takeoff at Ely Airport. Direct route to Rogers Dry Lake. Landing at Edwards AFB. Fictitious flight (July 8, 1965).

- **X-15AD-4 Groom Lake to Edwards (Takeoff)**
  X-15AD-4 ready for takeoff at Area 51/ Groom Lake. Direct route to Rogers Dry Lake. Landing at Edwards AFB. Fictitious flight (August 19, 1969).

- **X-15A-2 SE-2 at Edwards (Takeoff)**
  X-15A-2 SE-2 ready for inspection and takeoff at Edwards AFB. Fictitious flight (January 22, 1965).

Important

- Please note that the X-15 custom aircraft systems are reset when a new X-15A-2 SE aircraft is loaded in the simulator. This is because the X-15A-2 SE addon uses its own proprietary variables in addition the simulator's variables. Unfortunately, due to software limitations on the current simulation platforms, these custom variables are not memorized between flights.

- If the panels appear "frozen" after a new aircraft was loaded while in flight, simply end the current flight and start a new flight with the new X-15A-2 SE aircraft. Note that the correct initialization and ignition sequence procedures must be performed before flight each time a new X-15A-2 SE aircraft is loaded in the simulator.
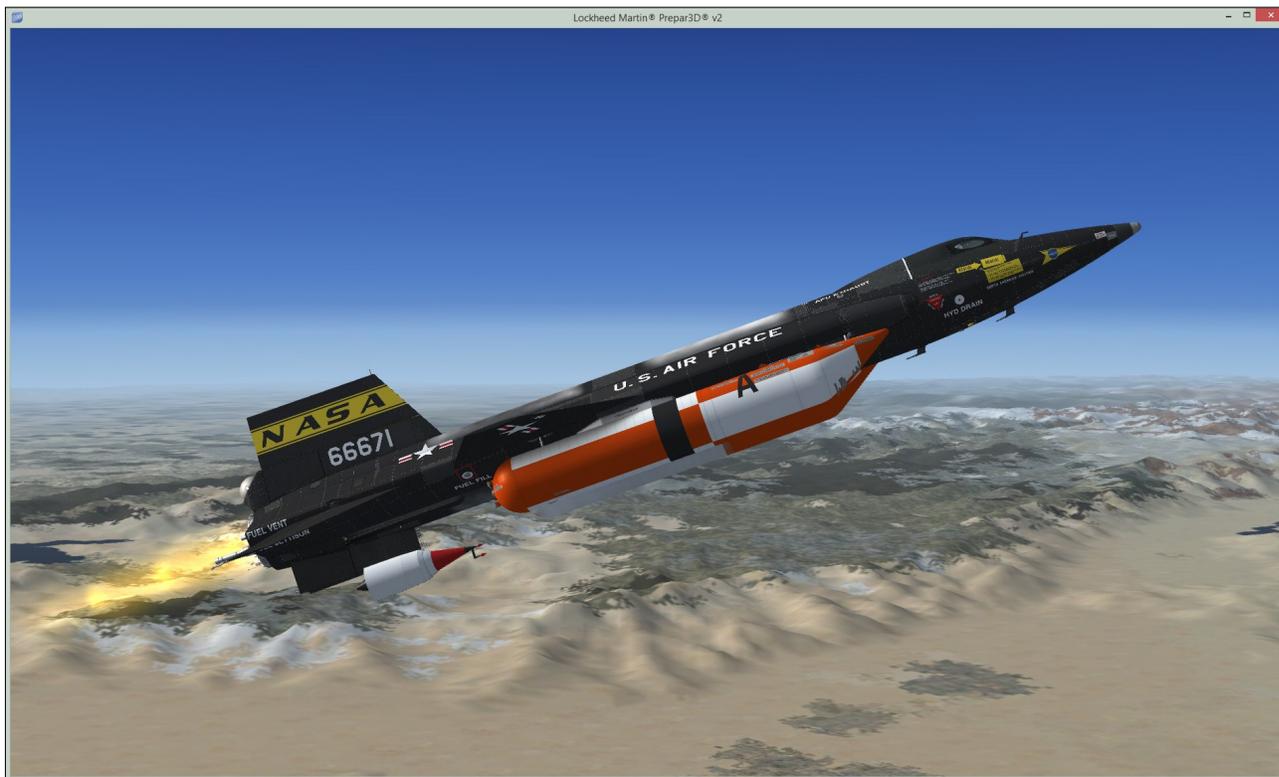
The flight model of the X-15A-2 SE addon was developed with the desktop pilot in mind so he/she can have fun while maintaining stability and control of the aircraft at all flight regimes allowed by the simulator.

We do not pretend that the flight model reproduces the exact flight characteristics of the real X-15 rocket plane, which would be practically impossible to achieve on the currently available simulation platforms, but we tried our best to develop a unique addon that is fun to fly while pushing the simulator to its limits and simulating nearly every step and procedure that were required in a real, typical X-15 mission.

The X-15A-2 SE addon was designed to simulate rocket propulsion and its related fuel systems including, in the case of the X-15, the use of three different propellants and their pressurization methods. Therefore, "CTRL-E" (the standard auto-start command in the simulator) will not work with the X-15 as it does with conventional piston or jet aircraft.

Instead, referring to the quick-start procedures, you must at the very least power the X-15 from an external source, refuel the aircraft from the service panel, start the APUs and generators, switch on the stable platform in order to have functioning instruments, pressurize the propellant tanks and follow the engine precool, prime and ignition procedures.

Remember: the X-15 is no ordinary airplane!

You can also use the (fictitious) automatic sequence start button [76, fig. 5-1] on the main panel to start the engine without going through the normal procedures or the quick-start procedures. However, following each step presented in the manual will make your overall X-15 experience much more realistic and enjoyable.

Since we are taking off from the ground, because there is no B-52 carrier in the simulator

to fly our X-15 addon to a proper altitude and heading before launch, we should treat the X-15 as, well, a "B-52 addon" until we reach our intended launch point. This means that we should aim for a Mach .78/FL450 launch while respecting the X-15's limitations.

Whichever starting method you previously selected, the unlimited fuel option switch [27, fig. 5-3], on the service panel, should be moved to **ON** for this type of practice flight with a fictitious takeoff from the ground.

You can also use the slew mode or the map view to position the aircraft at launch altitude and speed. Taking off from the ground is rather fun however, and is something the real X-15 pilots could not do! Refer to your simulator's manual for more information about the slew mode and the map.

We found that the best way to achieve takeoff is to accelerate on the runway centerline with the engine at about **75%** and to use the throttle [12, fig. 5-4] as required until the actual launch (Mach .78/FL450).

The airspeed indicator [5, fig. 5-1] on the X-15 main instrument panel is provided with a "barberpole" (actually a small red pointer on the left upper side of the instrument) which limits the airspeed at low altitudes to around 690 KIAS. As the aircraft climbs through 26,000 feet, the barberpole pointer moves to allow higher airspeeds thus reflecting the lower air density. The important thing to remember is that the indicated airspeed must be kept below the barberpole indicated value. You may refer to "Aircraft Reference Information" for other airspeed vs altitude limitations.

Rotate at **260-280 KIAS** in a smooth but swift pull-up to about **30 degrees nose-up** while retracting the gear. You may want to use the pitch error pointer (the small horizontal pointer on the left side of the attitude indicator [9, fig. 5-1]) and the pitch angle set control knob [16, fig. 5-1] (a separate instrument located at the lower right corner of the attitude indicator) to fine tune your pitch angle.

Before takeoff, select the pitch angle you want with the pitch angle selector control knob (the small lever must be clicked to get positive angles). As you maneuver the aircraft to within +5 or -5 degrees of your selected pitch, the

pitch error pointer on the left side of the eight-ball (attitude indicator) will act as a vernier pitch indicator which you can use for fine-tuning the pitch angle. Initial pitch-up and precise pitch angle control was an essential part in every X-15 mission. You should first approximate the desired pitch angle with the ball and then focus on the pointer for precise adjustments. The pointer moves in the same direction as the ball so it acts as a magnifying glass for pitch.

Be careful not to take too long to achieve the correct pitch or the airspeed may get out of hand. In this case, you may need to pitch up to very steep attitudes in order to regain airspeed control.

As you climb through FL450, check your IAS and try to maintain at least **350-400 KIAS** by carefully adjusting your pitch. Remember that you should be flying trimmed and leveled at around **Mach .78** and **FL450** before fully opening the throttle.

Once the launch altitude and speed are attained, you may proceed with the launch itself, which in our case is merely a question of setting the throttle to **100%** (with the unlimited fuel option switch [27, fig. 5-3], on the service panel, to **ON**) since the normal start-up procedures were performed on the ground.

Optional Procedures:

If you want a more realistic mission from this point on, with a limited engine burn time, you can shut down the engine by first retarding the throttle to 50%, then by moving the throttle outboard to OFF (right-clicking the throttle handle). Then, perform the following procedures:

1. *Engine master switch [63, fig. 5-1] – **OFF.***

2. *Unlimited fuel option switch [27, fig. 5-3] – **OFF.***

3. *Engine timer [11, fig. 5-1] – Push knob for **RESET.***

4. *Engine master switch [63, fig. 5-1] – **ON.***

5. *Engine precool switch [61, fig. 5-1] – **PRECOOL.***

6. *Engine prime switch [56, fig. 5-1] – **PRIME.***

7. *Igniter idle switch [53, fig. 5-1] –* **IGNITER. Wait about 10 seconds.**

8. *Ready-to-launch switch [52, fig. 5-1] –* **ON.**

9. *Throttle [12, fig. 5-4] –* **START (click and then move inboard to 50%).** *Throttle must be moved to 50% by the time the idle-end (amber) caution light [2b, fig. 5-1] comes on. Note that combustion in the main thrust chamber of the XLR-99 engine will start almost instantly when the throttle lever is moved.*

These steps would simulate a true high-altitude launch with limited fuel.

Once again (as during most X-15 missions), you should pitch up to about **30-35 degrees** (in reality, each mission called for a very accurate angle that can be set with the attitude indicator's vernier pointer and the pitch angle selector knob), maintain the throttle to **100%** and watch the X-15 accelerate. Mach 4.65 seems to be a hard limit of the simulator.

We recommend not exceeding 200,000 feet because the simulator has an unpredictable behavior beyond that point. Remember that the highest altitude attained by the real X-15A-2 rocket plane was 249,000 feet (August 3, 1966) and that most high speed flights were performed at even lower altitudes.

The main instrument panel is provided with a dynamic pressure gauge [10, fig. 5-1] which allows you to "see" how much air is actually hitting your wings and control surfaces. On the low side of the gauge (low airspeeds or very high altitudes) you see that not much control is possible below 250 psf (hence the high rotation speeds on takeoff). Unfortunately, the ballistic control rockets on the X-15 are not (yet) supported in the current flight simulation platforms, so control at very high altitudes and at very low dynamic pressure is kind of touchy. Be careful not to exceed the maximum dynamic pressure and acceleration values (again, you may refer to the "Aircraft Reference Information") or structural damage and/or "skin overheating" may occur!

During your mission, it is recommended to use an extra spot plane view, as visibility out of the cockpit is rather limited, especially at high pitch angles. It also makes for some great screenshots!

An engine timer [11, fig. 5-1] was installed in the X-15 equipped with the XLR-99 engine. The timer was automatically started during the ignition sequence and would tell the pilot when to shut down the engine, depending on the mission's objectives (altitude and speed to be attained). You can use the engine timer (located on top of the main instrument panel) for the same purpose.

If we exclude the climb to the launch altitude (during captive flight), a typical X-15A-2 mission would last for about 10 minutes, of which about 90 seconds (no external tanks) to 150 seconds (external tanks installed) saw the engine burning. The remainder of the flight was jettisoning the empty external propellant tanks, maintaining course while on a ballistic trajectory at several times the speed of sound, holding the correct angle of attack for reentry into the earth's atmosphere, decelerating with the speed brakes, jettisoning the remaining propellants, and finally, gliding your way back home. This is the way you should fly the X-15A-2 SE addon in the simulator as well.

Get to know the Mojave Desert and the emergency landing sites that this incredible landscape has to offer and try to make it back to Edwards or land on some dry lakes, as your simulation platform provides you with many strips and Air Force bases in the area. Be aware however that at X-15 speeds and altitudes, the distances between the landing areas appear quite short and therefore require accurate descent planning. Of course, flat sand does the trick as well, as long as it is not too soft.

You may want to switch to the trapezoidal windows for the final approach, as they provide more visibility, move your view point slightly to the left to better see the runway, and make the engine timer invisible or use the invisible canopy mode.

Approach at 300 KIAS (flaps down, 100 feet AGL), drop the gear right before flare and touchdown at 174-200 KIAS. Don't forget to jettison the ventral (or ramjet) before landing.

Refer to "Landing" for complete approach and landing procedures. *Happy record breaking!*

X-15A-2 AIRCRAFT REFERENCE INFORMATION

APPENDIX 4

Engine

One (1) Reaction Motors XLR-99 "throttable" liquid-fuel turborocket engine	60,000 lbs (thrust)

Aircraft Weight with External Tanks

Launch	51,600 lbs
Burnout (drop tanks jettisoned)	16,500 lbs
Landing (drop tanks jettisoned)	15,600 lbs

Aircraft Weight without External Tanks

Launch	32,250 lbs
Burnout	16,200 lbs
Landing	15,500 lbs

Speed Limitations

Note: The highest Mach number attained by the real X-15A-2 rocket plane was Mach 6.7 (October 3, 1967), the fastest flight of the X-15 research program. The current maximum speed attainable in the simulator is approx. Mach 4.65.

M_{MO} – Maximum Aircraft Operating Speed (Mach)	4.65 Mach
Maximum Speed with External Tanks Attached (Mach)	2.6 Mach
V_{LO} – Maximum Gear Operating Speed	300 KIAS
V_{LE} – Maximum Landing Gear Extension Speed	300 KIAS
V_{FE} – Maximum Flap Extended Speed (40 degrees)	300 KIAS
q – Maximum Dynamic Pressure without External Tanks	2200 psf
q – Maximum Dynamic Pressure with External Tanks	1000 psf
Maximum Acceleration (above 50,000 feet)	8 G

Mach Limitations vs Altitude

10,000 feet	0.8 Mach
20,000 feet	1.6 Mach
30,000 feet	1.8 Mach
40,000 feet	2.8 Mach
50,000 feet	3.5 Mach
60,000 feet	4.0 Mach
70,000 to 100,000 feet	4.65 Mach

Fictitious Ground Takeoff in the Simulator (standard temperature, sea level pressure altitude)

Note: The real X-15A-2 was not designed for a normal takeoff from the ground but was launched at a high altitude from a modified B-52 carrier. The X-15A-2 SE addon can take off from the ground, like any other aircraft in the simulator.

V_1 – Aircraft Takeoff Decision Speed (51,600 lbs)	250 KIAS
V_R – Aircraft Rotation Speed	275 KIAS
V_2 – Aircraft Takeoff Safety Speed	290 KIAS

Launch from a Fictitious Carrier Aircraft in the Simulator

Note: It is possible to simulate a high altitude launch from a fictitious carrier aircraft by using the slew mode commands* to reposition the X-15A-2 without flying in real time or by changing the altitude and speed settings in the map dialog box. A high altitude launch flight can also be loaded.

Recommended Launch Altitude	38,000 to 45,000 feet
Recommended Launch Speed	0.75 to 0.82 Mach

External Propellant Tanks Release

Note: Under normal flight conditions, external tanks should be released as soon as practical after they are empty, at about 70,000 feet and Mach 2.1, in a zero-G normal load factor condition and an angle of attack of about 10 degrees. The external tanks must be released before an attempt is made to jettison internal system propellants.

The maximum Mach number to be attained by the X-15A-2 with the external tanks attached is 2.6. The tanks must be released before reaching that speed. This limit is imposed because flight characteristics for this configuration have not been determined for higher Mach numbers.

Maximum Mach Number with External Tanks Attached	2.6 Mach
Recommended Mach Number for External Tanks Release	2.0 to 2.3 Mach
Recommended Altitude for External Tanks Release	65,000 to 75,000 feet
Maximum Angle of Attack with External Tanks Attached	16 degrees
Recommended Angle of Attack for External Tanks Release	5 to 10 degrees
Normal Load Factor Condition Recommended	0-G

Altitude Limitations (Typical)

Note: The highest altitude attained by the real-world X-15A-2 aircraft was 249,000 feet (August 3, 1966).

Aircraft Operating Altitude	45,000 to 150,000 feet
Aircraft Ceiling (maximum) Altitude	350,000 feet

Other Limitations (Typical)

Maximum Allowable Rate of Roll	100 degrees per second

Speed Brakes

The speed brakes are not to be used at full deflection below Mach 1.5.

Note: The speed brakes on this airplane are not designed for use as a low-speed drag device. Their design function is to provide necessary drag conditions for control of the airplane at supersonic speeds and relatively high altitudes.

Prohibited Maneuvers

The real X-15 airplane was restricted from performing the following maneuvers:

1. Spin
2. Snap Rolls
3. Snap Maneuvers

Propellant Jettison

Note: While approaching the landing site, the remaining propellants must be jettisoned to minimize fire or explosion hazards and to lower the weight of the aircraft.

Maximum Speed at 30,000 feet	0.60 Mach
Maximum Speed at 15,000 feet	0.45 Mach

Ventral (or Dummy Ramjet) Jettison

Note: Under normal flight conditions, the ventral (or the dummy ramjet) should not be jettisoned except during landing approach. The ventral (or ramjet) must be jettisoned to provide ground clearance for the landing gear.

Maximum Mach Number	**300 KIAS or 3.5 Mach, whichever comes first**
Recommended Altitude	**5000 feet**
Minimum Altitude	**1500 feet**
Maximum Angle of Attack	**16 degrees**
Maximum Rate of Roll	**30 degrees per second**

Landing

High Key Point (106 seconds from landing)	**15,200 feet, 300 KIAS, gear and flaps up (45-degree bank turn)**
180-Turn (82 seconds)	**11900 feet, 270 KIAS, gear and flaps up**
Low Key Point (58 seconds)	**8700 feet, 240 KIAS, gear and flaps up (180 degrees opposite to the runway)**
90-Degree Point (36 seconds)	**5800 feet, 240 KIAS, gear and flaps up (90 degrees perpendicular to the runway)**
Ventral (or ramjet) Jettison	**5000 feet, 240 KIAS (lined up with the runway)**
Flaps Extended (15 seconds)	**3200 feet, 240 KIAS, roll out of turn**
Gear Down (10 seconds)	**2700 feet, 240 KIAS, 1.29 G pullout**
Flare Completed	**2200 feet, 174 KIAS**
Touchdown (0 seconds)	**174 KIAS**
V_{REF} - Landing Approach Speed (flaps extended, gear down)	**174 KIAS**
Aircraft Stalling Speed (flaps up)	**140 KIAS**
Aircraft Stalling Speed (flaps down)	**100 KIAS**

Note: The real X-15A-2 aircraft reference information was modified for use in the simulator. For explanations of speeds used on this tab, see "V-speeds" in the Learning Center Glossary (Flight Simulator X).

*: For instructions on how to use the slew commands to reposition the aircraft without flying in real time, see "Slewing" in the Learning Center Glossary (Flight Simulator X).

X-15AD-4 AIRCRAFT REFERENCE INFORMATION

APPENDIX 5

Note: The X-15AD-4 is a fictitious delta wing X-15, based on different proposed configurations for future X-15 airplanes.

Engines

One (1) Reaction Motors XLR-99 "throttable" liquid-fuel turborocket engine	**60,000 lbs (thrust)**
Two (2) Thiokol "Castor 1" solid rocket boosters	**45,000 lbs (thrust X2)**

Aircraft Weight with Solid Rocket Boosters

Launch	**46,840 lbs**
Burnout (boosters jettisoned)	**16,500 lbs**
Landing (boosters jettisoned)	**15,600 lbs**

Aircraft Weight without Solid Rocket Boosters

Launch	**36,600 lbs**
Burnout	**19,200 lbs**
Landing	**17,500 lbs**

Speed Limitations

Note: The current maximum speed attainable in the simulator is approx. Mach 4.65.

M_{MO} – Maximum Aircraft Operating Speed (Mach)	**4.65 Mach**
Maximum Speed with Boosters Attached (Mach)	**2.6 Mach**
V_{LO} – Maximum Gear Operating Speed	**300 KIAS**
V_{LE} – Maximum Landing Gear Extension Speed	**300 KIAS**
q – Maximum Dynamic Pressure without Boosters	**2200 psf**
q – Maximum Dynamic Pressure with Boosters	**1000 psf**
Maximum Acceleration (above 50,000 feet)	**8 G**

Mach Limitations vs Altitude

10,000 feet	0.8 Mach
20,000 feet	1.6 Mach
30,000 feet	1.8 Mach
40,000 feet	2.8 Mach
50,000 feet	3.5 Mach
60,000 feet	4.0 Mach
70,000 to 100,000 feet	4.65 Mach

Fictitious Ground Takeoff in the Simulator (standard temperature, sea level pressure altitude)

Note: The X-15AD-4 addon can take off from the ground, like any other aircraft in the simulator.

V_1 – Aircraft Takeoff Decision Speed (51,600 lbs)	250 KIAS
V_R – Aircraft Rotation Speed	275 KIAS
V_2 – Aircraft Takeoff Safety Speed	290 KIAS

Launch from a Fictitious Carrier Aircraft in the Simulator

Note: It is possible to simulate a high altitude launch from a fictitious carrier aircraft by using the slew mode commands* to reposition the X-15AD-4 without flying in real time or by changing the altitude and speed settings in the map dialog box. A high altitude launch flight can also be loaded.

Recommended Launch Altitude	**38,000 to 45,000 feet**
Recommended Launch Speed	**0.75 to 0.82 Mach**

Solid Rocket Boosters Release

Note: Under normal flight conditions, solid rocket boosters should be released as soon as practical after they are burned out, at about 125,000 feet and Mach 2.8, in a zero-G normal load factor condition and an angle of attack of about 10 degrees.

The maximum Mach number to be reached by the X-15AD-4 with the solid rocket boosters attached is 2.8. The boosters must be released before reaching that speed. This limit is imposed because flight characteristics for this configuration have not been determined for higher Mach numbers.

Maximum Mach Number with Solid Rocket Boosters Attached	3.0 Mach
Recommended Mach Number for Solid Rocket Boosters Release	2.5 to 3.0 Mach
Recommended Altitude for Solid Rocket Boosters Release	80,000 to 150,000 feet
Maximum Angle of Attack with Solid Rocket Boosters Attached	16 degrees
Recommended Angle of Attack for Solid Rocket Boosters Release	5 to 10 degrees
Normal Load Factor Condition Recommended	0-G

Altitude Limitations (Typical)

Aircraft Operating Altitude	45,000 to 200,000 feet
Aircraft Ceiling (maximum) Altitude	520,000 feet

Other Limitations (Typical)

Maximum Allowable Rate of Roll	100 degrees per second

Speed Brakes

The speed brakes are not to be used at full deflection below Mach 1.5.

Note: The speed brakes on this airplane were not designed for use as a low-speed drag device. Their design function is to provide necessary drag conditions for control of the airplane at supersonic speeds and relatively high altitudes.

Prohibited Maneuvers

The real-world airplane was restricted from performing the following maneuvers:

1. Spin
2. Snap Rolls
3. Snap Maneuvers

Propellant Jettison

Note: While approaching the landing site, the remaining propellants must be jettisoned to minimize fire or explosion hazards and to lower the weight of the aircraft.

Maximum Speed at 30,000 feet	0.60 Mach
Maximum Speed at 15,000 feet	0.45 Mach

Dummy Ramjet Jettison

Note: Under normal flight conditions, the dummy ramjet should not be jettisoned except during landing approach. The ramjet must be jettisoned to provide ground clearance for the landing gear.

Maximum Mach Number	**300 KIAS or 3.5 Mach, whichever comes first**
Recommended Altitude	**5000 feet**
Minimum Altitude	**1500 feet**
Maximum Angle of Attack	**16 degrees**
Maximum Rate of Roll	**30 degrees per second**

Landing

High Key Point (106 seconds from landing)	**15,200 feet, 300 KIAS, gear and flaps up (45-degree bank turn)**
180-Turn (82 seconds)	**11900 feet, 270 KIAS, gear and flaps up**
Low Key Point (58 seconds)	**8700 feet, 240 KIAS, gear and flaps up (180 degrees opposite to the runway)**
90-Degree Point (36 seconds)	**5800 feet, 240 KIAS, gear and flaps up (90 degrees perpendicular to the runway)**
Ventral (or ramjet) Jettison	**5000 feet, 240 KIAS (lined up with the runway)**
Gear Down (10 seconds)	**2700 feet, 240 KIAS, 1.29 G pullout**
Flare Completed	**2200 feet, 174 KIAS**
Touchdown (0 seconds)	**174 KIAS**
V_{REF} - Landing Approach Speed (flaps extended, gear down)	**174 KIAS**
Aircraft Stalling Speed	**100 KIAS**

Note: For explanations of speeds used on this tab, see "V-speeds" in the Learning Center Glossary (Flight Simulator X).

*: For instructions on how to use the slew commands to reposition the aircraft without flying in real time, see "Slewing" in the Learning Center Glossary (Flight Simulator X).

OPERATING LIMITATIONS APPENDIX 6

X-15A-2 WITH EXTERNAL TANKS LIMITATIONS

Airspeed Limitations

a. The maximum q (dynamic pressure) is 1000 psf with the external tanks attached.

b. The maximum allowable Mach number with the external tanks installed is Mach 2.6. This limit is imposed because flight characteristics for this configuration have not been determined for higher Mach numbers.

Symmetrical Acceleration Limitations

a. Symmetrical limitations with the external tanks attached are -2.2 G and -1.0 G.

External Tanks Release Limitations

a. **Captive Flight** - There is no information available concerning external tanks release during captive flight.

b. **After Launch** - When external tanks are to be released, airplane transient motions (pitch, roll, and yaw) should be kept to a minimum, and the tanks must be pressurized.

c. **Full Tanks** - When engine malfunction oc-

curs immediately after launch, the external tanks should be released full as soon as possible and before attempting a restart. The airplane angle-of-attack should be approximately 10 degrees at tank release. If an engine restart was accomplished more than 20 seconds after launch with external tanks attached, the ensuing pull up would cause the G-limit or dynamic pressure limit of the airplane to be exceeded.

d. **Empty Tanks** - The external tanks should be released as soon as practical after they are empty

INSTRUMENT MARKINGS

Careful attention must be given to the instrument markings because the limitations shown on these instruments are not necessarily repeated in the text of this or any other section.

ENGINE LIMITATIONS

Refer to "Instruments Readings" for normal engine limitations.

CAPTIVE FLIGHT LIMITATIONS

Control surfaces may be deflected only individually. Full throw of the vertical stabilizer or flaps is permissible up to 300 knots EAS.

The horizontal stabilizer may be deflected full throw at 200 knots EAS, decreasing linearly to one-half throw at 300 knots EAS.

To avoid possible buffet on both the X-15 and carrier airplane, the speed brakes should not be extended beyond 10 degrees.

LAUNCH LIMITATIONS

Launch from the B-52 carrier airplane should be made under the following conditions:

1. Mach .75 at 35,000 feet to Mach .82 at 45,000 feet.

2. Carrier airplane in 1 G symmetrical flight.

3. X-15 control surfaces as follows:

    a. Vertical stabilizer-ventral neutral.

    b. Horizontal stabilizer neutral in roll and 0 degrees to -2 degrees (leading edge down) in pitch. The setting of -2 degrees should not be used until some familiarity with launch characteristics has been gained at the 0-degree setting.

    c. Launch should not be made with the ventral (or ramjet) jettisoned or not installed, except when the scheduled mission specifically requires it.

AIRSPEED LIMITATIONS

Maximum Allowable Airspeed

Refer to "Aircraft Reference Information (X-15A-2)" for the maximum allowable Mach number for varying flight altitudes.

The maximum q (dynamic pressure) is 2200 psf with modified movable vertical stabilizer and ventral.

Because of the exploratory nature of the X-15 research program, limitations for all flights beyond 3.5 Mach number will be based on separate mission analysis.

Landing Gear and Wing Flaps Lowering Speed

Maximum allowable airspeed for extending the landing gear and wing flaps, or for flight with the landing gear and wing flaps fully extended, is 300 knots IAS. Flight with the landing gear and flaps extended at speeds above 300 knots IAS may cause structural damage.

VENTRAL JETTISON LIMITATIONS

For all flights where the ventral (or dummy ramjet) is installed for launch, the ventral (or ramjet) should not be jettisoned at speeds above 300 knots IAS or Mach 3.5, whichever is lower. Under normal flight conditions, with the SAS functioning properly, the ventral should not be jettisoned except during the landing approach.

In the event of controllability problems arising from the loss of various SAS modes (primarily loss of the SAS roll mode), jettisoning of the ventral greatly improves airplane handling characteristics in the Mach number range of 2.0 to 3.5.

With the ventral jettisoned, the following limits apply:

a. Maximum angle of attack: 16 degrees.

b. Maximum rate of roll: 30 degrees per second.

c. Maximum Mach number: 3.5, or depending on mission.

SPEED BRAKE OPERATION

The upper and lower speed brakes must be operated simultaneously and symmetrically. This restriction is imposed because no analysis has been conducted to determine limitations required for asymmetrical operation of the speed brakes.

Be cautious when using speed brakes for approach control, because rate of descent approximately doubles with the speed brakes open.

Normally, the speed brake handles [13-14, fig. 5-4] are mechanically interconnected to ensure simultaneous and symmetrical operation of the speed brakes.

SAS LIMITATIONS

Under conditions of a single system APU failure or failure of either the roll or yaw functions, lateral directional control problems can be encountered in the speed range of Mach 2.5 to 6.0 and at angles of attack in excess of 8 degrees nose up with the ventral installed. Should control problems be encountered under these conditions, the following recovery techniques should be employed:

a. Reduce angle of attack.

b. Extend speed brakes.

c. Jettison ventral if below the airspeed limit for jettisoning the ventral.

Note: If the ventral is not installed, the failures noted previously will not seriously affect airplane controllability.

ACCELERATION LIMITATIONS

In order to ensure correct interpretation of the two basic types of acceleration limitations imposed on this airplane, the following definitions apply:

a. Symmetrical flight is that where airplane bank angle is constant.

b. Asymmetrical flight is that involving a bank angle change rate, i.e., rolling flight.

Symmetrical Acceleration Limitations

Negative G imposed at low engine propellant levels may result in premature main chamber burnout.

Asymmetrical Acceleration Limitations

At burnout gross weight (15,119 pounds), asymmetrical limitations are 5.2 G and 0 G.

ROLL LIMITATIONS

The maximum allowable rate of roll is 100 degrees per second. Roll coupling can be encountered at the higher Mach numbers and angles of attack.

YAW (SIDESLIP) LIMITATIONS

Abrupt yawing maneuvers utilizing maximum rudder rate and deflection should not be performed. Yaw maneuvers exceeding one half of the maximum rudder deflection in one direction, followed immediately by a similar deflection in the opposite direction should not be performed.

PROHIBITED MANEUVERS

The air plane is restricted from performing the following maneuvers:

a. Spins.

b. Snap rolls.

c. Snap maneuvers.

BCS LIMITATIONS

To conserve catalyst bed life, continuous operation of the ballistic rocket motors should be limited to 3 seconds for ground or captive flight tests.

LANDING LIMITATIONS

Information on sink speed/angle-of-attack limits for touchdown will be supplied when available.

CENTER-OF-GRAVITY LIMITATIONS

Since the in-flight horizontal and vertical centers of gravity are automatically controlled as a result of the design of the engine and engine turbopump propellant systems, the horizontal CG normally is maintained within the forward and aft aerodynamic limits. The vertical CG will be within the engine adjustment provisions if all of the design equipment is in-

stalled. The engine and engine turbopump propellant jettison rate is automatically controlled to prevent an unsatisfactory CG condition. If airplane response during jettisoning indicates an unsatisfactory trim condition, selective jettisoning of the engine propellants should be accomplished.

WEIGHT LIMITATIONS

The design of the airplane precludes the possibility of overloading at launch. The structural design weight for landing does not include engine propellants or engine turbopump monopropellant; therefore, they must be jettisoned before landing.

Minimum Control Speeds

Minimum control speeds are not determined by a maximum lift coefficient, but by directional stability and estimated regions of buffet.

Spins and Recovery

Intentional spins in this airplane are prohibited.

Ventral Attached – Fully developed spins are not apt to occur with the ventral attached, except possibly due to reduced directional stability at an angle of attack in excess of 20 degrees. If there is any yawing or rolling due to this reduced stability and a spin is entered, the stick should immediately be moved in the direction of spin rotation and full opposite rudder (against rotation) should be applied. When the spin has stopped, the stick should be centered and moved forward to prevent a spin in the opposite direction, and the rudder neutralized. Do not immediately attempt to level the wings by moving the stick against the direction of rotation.

Ventral Jettisoned – With the ventral jettisoned and the airplane at an angle of attack in excess of 17.5 degrees, a spin may be developed from which recovery may be difficult or impossible; therefore, jettisoning of this surface should be delayed as long as possible before entering the landing pattern. Recom-

mended recovery is the same as when the ventral is attached: The stick should be moved in the direction of spin rotation and full opposite rudder should be applied. When rotation stops, the stick should be centered and moved forward to prevent a spin in the opposite direction, and the rudder neutralized.

Flight Control Effectiveness

Pitch Control – For flight above approximately Mach 1.4, the maximum normal acceleration obtainable can be limited by the maximum stabilizer deflection available. Maximum normal acceleration can also be limited by an estimated initial buffet effect between Mach .5 and Mach 1.0. Below Mach .5, the limit is imposed by the reduced directional stability at angles of attack above 20 degrees. At low speeds, the angle of attack for buffet onset due to airflow separation on the wing is about 13 degrees. Turbulence behind the vertical stabilizer may cause considerable buffet at any angle of attack. Therefore, buffet onset should not be considered as a stall warning until buffet characteristics have been determined from flight experience.

Roll Control – Adequate roll control is available throughout the Mach number range from high-speed flight to landing speeds. Rate of roll is limited to 50 degrees per second when the SAS roll gain is set on high gain. At lower angle of attack, there is slight favorable yaw (yaw in direction of roll application). As the angle of attack increases above Mach .6, there is a decrease in this yaw. At low Mach numbers and in the transonic region, there is very little change in roll effectiveness with angle of attack. Roll effectiveness increases with an increase in angle of attack above Mach 2.6. Roll coupling does not present a problem with or without SAS, except at extremely high Mach numbers at high altitudes. Roll coupling does not occur at as low an altitude with SAS in as it does with SAS out, and in either case, roll coupling would not occur below approximately 100,000 feet. Maximum rates of roll at other Mach numbers and altitudes are limited by the

maximum differential horizontal stabilizer deflection.

Yaw Control – Pilot feel is supplied as a function of surface deflection, and the variation of pedal force with pedal travel is linear. The upper and lower (ventral) vertical stabilizers give good directional control throughout the flight range. The ventral is effective in retaining stability at high angles of attack where the upper vertical stabilizer is partially blanketed by the wing and fuselage. At high Mach numbers and high angles of attack, this increase in effectiveness of the ventral produces an appreciable amount of roll in a direction opposite to the yaw. Although the ventral is jettisoned before landing, the upper vertical stabilizer supplies adequate directional control for low-speed flight up to 17.5 degrees angle of attack.

Speed Brakes

At supersonic Mach numbers, in addition to increasing the effectiveness of the vertical stabilizers and improving directional stability, the speed brakes increase longitudinal stability. As angle of attack increases, the effect of the speed brakes on longitudinal and directional stability also increases. In addition to improving stability at high Mach numbers, the speed brakes obviously provide additional drag to the airplane. At subsonic Mach numbers, the speed brakes reduce both the longitudinal and the directional stability. During the glide, which would occur at lower altitudes, the basic drag of the airplane gives high rates of descent, and the increase in rate of descent due to use of the speed brakes is undesirable.

Flight Configuration Characteristics

Launch – Launch from the carrier airplane can be accomplished satisfactorily for 1 G flight conditions during carrier airplane acceleration, climb, and cruise as well as the design launch conditions.

1. If a -5-degree stabilizer deflection is used for an empty-weight launch, the airplane will rotate about the forward part of the pylon, slide outboard, and hit the engine nacelles and wing tip. Full-weight launches with -5-degree stabilizer deflection are ac-

ceptable; however, it is recommended that a stabilizer deflection of zero to +5 degrees be used for all launches.

2. The airplane rolls outboard upon release from the carrier. Roll control is very sensitive at this point, and no more than 2 degrees differential stabilizer deflection should be used if a correction is to be made.

Glide – Refer to "Landing".

X-15A-2 with External Tanks Attached

Flight characteristics of the X-15A-2 in the clean configuration will be similar to those of the other X-15 airplanes. The flight characteristics discussed herein reflect those of the design mission only. Flight characteristics during missions that are significantly different than that of the design mission are not included.

Launch (external tanks attached) – Engine thrust will produce a nose-down pitch tendency, since the airplane center of gravity with the external tanks attached is lower than the engine thrust line. However, the horizontal tail is very effective and more than adequate to counteract this condition.

The angle-of-attack limit for directional stability can easily be exceeded in the pull-up following launch. Caution should be exercised to avoid exceeding this limit. The airplane tends to pitch nose-up if loss of thrust is experienced shortly after launch. Immediate pilot action may be required to prevent the angle-of-attack limit from being exceeded.

External tanks attached – With external tanks attached, the flight characteristics remain satisfactory throughout the design mission. However, the airplane exhibits reduced levels of both longitudinal and directional stability. The longitudinal control forces required to produce a desired change in airplane attitude are reduced, as compared to the clean configuration (external tanks released) for the same flight condition. Therefore, the maximum recommended angle of attack is reduced, because of this reduction in directional and longitudinal stability.

External tanks released – The external tanks

are released at Mach 2.1 at 70,000 feet in a zero-G normal load factor condition. However, wind tunnel results indicate that the external tank release characteristics are relatively un-changed between Mach 1.9 and Mach 2.4 as long as the jettison envelope is observed.

SELECTED BIBLIOGRAPHY APPENDIX 8

These books and films provided us with invaluable information during the development of the X-15A-2 Special Edition v2.0 addon and we highly recommend them to all X-15 fans:

Books

Hypersonic: The Story of the North American X-15
Dennis R. Jenkins, Tony Landis
Publisher: Specialty Press (2003)
Hardcover: 276 pages
ISBN: 158007068X

X-15 Photo Scrapbook
Tony R. Landis
Publisher: Specialty Press (2003)
Paperback: 108 pages
ISBN: 1580070744

X-15: Extending the Frontiers of Flight (with CD-ROM)
Dennis R. Jenkins
Publisher: NASA (2007)
Hardcover: 681 pages.
ISBN: 9780160792854

At the Edge of Space: The X-15 Flight Program
Milton O. Thompson
Publisher: Smithsonian Books (2003)
Paperback: 375 pages
ISBN: 1588340783

The X-15 Rocket Plane: Flying the First Wings into Space
Michelle Evans
Publisher: University of Nebraska Press (2013)
Hardcover: 451 pages
ISBN: 9780803228405

X-15: The World's Fastest Rocket Plane and the Pilots who Ushered in the Space Age
John Anderson and Richard Passman
Publisher: Zenith Press and Smithsonian Institution (2014)
Hardcover: 144 pages
ISBN: 9780760344453

X-15: The NASA Mission Reports (with CD-ROM)
(contains two reprints of the X-15/X-15A-2 flight manuals)
Robert Godwin (Editor)
Publisher: Apogee Books (2000)
Paperback: 408 pages
ISBN: 1896522653

North American X-15 Rocket Plane Pilot's Flight Operating Instructions
(reprint)
Publisher: Periscope Films (2006)
Paperback: 120 pages
ISBN: 1411698246

The X-Planes: X-1 to X-45 (3rd Edition)
(not only about the X-15)
Jay Miller
Publisher: Midland (2001)
Hardcover: 440 pages
ISBN: 1857801091

X-Planes Photo Scrapbook (Paperback)
(not only about the X-15)
Dennis R. Jenkins
Publisher: Specialty Press (2004)
Paperback: 144 pages
ISBN: 1580070760

Manuals

X-15 Utility Flight Manual
Publisher : U.S. Air Force and North American Aviation (1961 to 1964)
Archive: 200 pages

X-15A-2 Utility Flight Manual
Publisher : U.S. Air Force and North American Aviation (1966)
Archive: 225 pages

Films about the X-15 and Hypersonic Flight

X-15: The Edge of Space
(over 10 hours of rare film footage, NASA documentaries and contractor films on the X-15)
Studio: Spacecraft Films
DVD Release Year: 2006
Run Time: Over 10 hours (3 DVDs)

Without Limits: NASA Test Projects
(not only about the X-15)
Documentary series (1997)
Studio: Image Entertainment
DVD Release Year: 2002
Run Time: 150 minutes

Rocket Science
(not only about the X-15)
Documentary series (2003)
Studio: Casablanca Media TV

DVD Release Year: 2004
Run Time: 540 minutes (3 DVDs)

NOVA – Faster Than Sound
(not about the X-15, but a must for anyone interested in supersonic flight, the Bell X-1 rocket plane and the XLR-11 engine)
Documentary (1996)
Studio: Image Entertainment
DVD Release Year: 2001
Run Time: 60 minutes

External Internet Links

Research Project X-15 (video, NASA short)

US Air Force X-15 Hypersonic Aircraft (video)

X-15A-2 Flight Test with External Fuel Tanks (video)

X-15A-2 Side View of Damage After Mach 6.7 Flight (video)

X-15A-2 Approach and Landing (video)

Lecture at the National Air and Space Museum Smithsonian Institution by X-15 pilot Bill Dana

Joe Engle: The X-15, the Pilot and the Space Shuttle

X-15 Image Gallery (NASA)

North American X-15A-2 (National Museum of the USAF)

X-15 Walkaround (Smithsonian Air & Space)

Fact Sheet: X-15 Hypersonic Research Program

X-15 Research Results

Note: Xtreme Prototypes is not responsible for the accuracy, legality or content of external websites. The inclusion of a link to an organization's or individual's website does not constitute an endorsement or an approval. Information on linked website pages may become dated or change without notice. Please report any inappropriate content.

HELP AND SUPPORT

Answers to most technical questions can be found in the present manual and in the [online documentation](#). Both the manual and the online help system are updated regularly, so we encourage you to visit our website frequently.

We've added a "Frequently Asked Questions" section at the end of the documentation to help you find answers to most frequent questions and issues you may encounter while installing or flying the X-15A-2 SE v2.0 addon on your simulation platform.

Known issues are discussed in the "Know Issues" section.

If you don't find what you are looking for in the documentation and need some help, please contact us. We are here to help and we'll try our best to answer you within one business day.

We offer free, personalized technical support via email to registered users only (in English or French).

HOW TO CONTACT US

The best way to reach us is via the contact forms on our website:

For sales support or general inquiries – If you need help with your order or simply want to send us a message, please use our general contact form:

https://xtremeprototypes.com/en/shopcustcontact.asp

For technical support – If you need technical support for your addon, please fill out our technical support request form:

https://xtremeprototypes.com/en/shopcustcontactsupport.asp

Please make sure all the fields in the form are filled out correctly and provide us with as much information as possible about your technical issue.

Find us on [f]

https://www.facebook.com/XtremePrototypes/

PATCHES AND UPDATES

Please visit our "Downloads" section on our website for the latest patches and updates for your addon:

http://xtremeprototypes.com/en/downloads.asp

MANUALS

Manuals are updated regularly. Please make sure you have the latest revision:

http://xtremeprototypes.com/en/manuals_downloads.asp

WE NEED YOUR FEEDBACK

Our products are designed to evolve with time, according to the feedback we receive from our most valuable users and from anyone interested in our products, flight simulation or aviation in general. Please let us know your comments, ideas and suggestions.

We appreciate constructive feedback from our users, so please don't hesitate to report any issue or bug you might have experienced when flying the X-15A-2 SE addon.

We thank you for helping us developing great addons!

If you were involved in the real X-15 program during the 1950's and 60's and would be interested in helping us improving this addon, it would be an honor to hear from you.

FREQUENTLY ASKED QUESTIONS

Answers to most questions can be found in the documentation contained in the present manual and in the online help system. Answers to other questions may be found in this section.

The manual and the online help system are updated regularly, so we encourage you to visit our website frequently. Please make sure you have access to the latest revision.

GENERAL

What do I get with my X-15A-2 SE v2.0 addon?

Your software license gives you:

- Five versions of the X-15A-2 SE addon, for six supported simulation platforms (Prepar3D® v4, Prepar3D® v2/3, Prepar3D® v1, FSX Steam®, FSX).

- A 280-page printable PDF manual.

- An online help system.

- Free patches and updates.

- Free personalized technical support via email, in English or French.

For the list of features included with the X-15A-2 SE v2.0 addon, refer to "Addon Description"

in this manual or to the product page on our website.

Is the manual available in print form or PDF?

Yes. A 280-page printable PDF manual (the present document) is available for this addon.

You can download the complete manual for this addon at any time from our "Downloads" section on our website (select "Manuals"):

http://xtremeprototypes.com/en/manuals_downloads.asp

All our manuals are free and available to the public. Registered users can print copies of the manual for their own use.

Manuals are updated frequently. Please make sure you have the most recent revision.

In addition to the PDF manual, an online help system is also available for this addon:

http://xtremeprototypes.com/en/X-15A-2SE_help/X-15A-2SEUserManual.html

Online help systems offer much more features than PDF manuals, such as high-resolution images, interactive multimedia contents, hyperlinks, keywords, and a search engine, and they occupy less space than printed documents. In addition, online manuals are always up-to-date, so you are never left behind.

Online help systems can be viewed in your Internet browser on your desktop/laptop computer or tablet. Like many pilots in the real world, you can use your iPad®, Windows® or Android® tablet as an aviator kneeboard while flying the aircraft in the simulator.

You can use the table of contents on the left to browse the different topics or search for phrases and keywords to obtain the information you want quickly. Keywords and hyperlinks are important features of online manuals that will help you navigate and find what you need.

How do I get access to the online manual?

You can access the online help system for your addon at any time by visiting our website. Online help systems are updated frequently:

http://xtremeprototypes.com/en/X-15A-2SE_help/X-15A-2SEUserManual.html

Where is the PDF manual?

You can download the complete 280-page manual for this addon from our "Downloads" section on our website (select "Manuals"):

http://xtremeprototypes.com/en/manuals_downloads.asp

All our manuals are free and available to the public. Registered users can print copies of the manual for their own use. Manuals are updated frequently. Please make sure you have the most recent revision.

Le manuel est-il disponible en français ? (Is the manual available in French?)

Non, pas pour l'instant. Cependant, nous offrons à nos utilisateurs francophones enregistrés une assistance technique en ligne personnalisée en français pour l'ensemble de nos produits.

Are all the X-15A-2 systems simulated?

Nearly all X-15A-2 systems that can be reproduced in Microsoft® Flight Simulator X or Lockheed Martin® Prepar3D® are simulated, except where otherwise noted in the documentation.

How realistic is the X-15A-2 SE addon?

The operation of the addon is very similar to the operation of the real aircraft. Nearly all systems, gauges, switches, light indicators and instruments are functional and behave like their original counterparts found in the real X-15A-2. However, while we regard this addon more as a simulator rather than a game, we cannot pretend that it is one hundred percent historically or technically accurate or that it truly reproduces all the flight characteristics of the real X-15A-2 rocket plane, which would be practically impossible to achieve on the currently available simulation platforms. Nevertheless, we tried our best to develop a unique and sophisticated product that puts the desktop pilot in command of one of the most extraordinary flying vehicles ever designed and let him/her forget for one moment that it's not for real.

At the time of publication, rocket engines and ballistic control for rocket airplanes were still not supported in either Microsoft® Flight Simulator X or Lockheed Martin® Prepar3D®. Your simulation platform still sees the X-15A-2's XLR-99 engine, and the solid rocket boosters on the X-15AD-4, as jet engines. Rocket-propelled flight is therefore not 100% accurate in the simulator although we tried our best to emulate it as much as we could in the flight model, considering the present limitations. We sincerely hope that all simulation platforms will offer support for rocket engines (and ballistic control) in the near future.

Because aerodynamic control surfaces become less and less effective above about 125,000 feet in the simulator as dynamic pressure decreases, we recommend flying the X-15A-2 addon below 200,000 feet. The simulator will still give you limited control at high altitudes, but flying will become more challenging.

Note that the highest altitude attained by the real X-15A-2 rocket plane was 249,000 feet (August 3, 1966) and that most high speed flights were performed at even lower altitudes.

Refer to "The X-15 Experience" for more information.

The real X-15 could not take off from the ground but was dropped at a high altitude from a B-52 carrier. Why can the X-15A-2 SE addon take off from the ground? This is unrealistic.

We know, but it's fun! This is a simulation after all, and many things that are not permitted in the real world can be done in a simulator. Plus, we thought that our users would like to take off from the ground in their new X-15 addon.

This also gives the beginner desktop pilot plenty of time to learn and perform the required preflight procedures while the aircraft in comfortably sitting on the ground instead of falling like a brick in mid-air.

(**Did you know?** The only time a rocket-powered research aircraft took off conventionally was in January 1949 with captain Chuck Yeager in command of the original Bell X-1. However, the X-1 had wheels on its main landing gear instead of steel skids like the X-15...)

For purists, it is possible to simulate a high altitude launch by using the slew mode commands to reposition the X-15 airplane without flying in real time. A second option is to change the altitude and speed settings in the map window, available from the "World" menu item on the simulator's top menu bar. You can also load one of the high altitude "launch" saved flights that come with the addon.

Taking off from the ground is rather fun however, and is something the real X-15 pilots could not do! Refer to your simulator's manual for more information about the slew mode and the map.

I am an X-15 fan but a beginner desktop pilot. Is the X-15A-2 SE addon too complex for me?

If you are a true X-15 fan and already have some knowledge about the aircraft and a desire to learn more, this addon is for you. This is your chance to go beyond books and films and jump in the cockpit of this extraordinary flying machine in a true simulation environment.

All the necessary information to fly the X-15A-2 SE addon is in the documentation. There are two sets of instructions: a detailed set, which contains the entire procedures involved in a real X-15A-2 flight (perfect for X-15 fans, beginners and more advanced desktop pilots alike), and a condensed set called "quick-start procedures", for those who want a shorter check list.

If this were not enough, our X-15A-2 SE addon can now be started automatically at the touch of a single "magic" red button, so anyone can take off quickly and easily and fly the beast.

The X-15A-2 SE v2.0 documentation contains a new section with complete system descriptions that was not included in the old v1.0 manual. All systems, switches, indicators, gauges, levers and handles are described in full.

The X-15 is certainly no ordinary aircraft and above all, an experimental vehicle equipped with a powerful rocket engine. This makes the X-15A-2 SE addon very different from more conventional piston or jet aircraft normally found in the simulator. Like a real X-15 test pilot, the desktop pilot needs some time to become familiar with the complex operation of this remarkable aircraft and to be able to perform the required procedures described in the manual. It is simply impossible to jump in the cockpit of the X-15A-2 SE addon and expect to start the rocket engine and to take off without following the correct procedures, like in the real aircraft.

If you're feeling overwhelmed by the cockpit of the X-15A-2, we suggest giving the manual a chance, as it was written with non-experienced pilots in mind. The aircraft is quite rewarding once mastered, but as most things in life, practice makes perfect!

Does my X-15A-2 SE addon come with a virtual cockpit?

Yes. The X-15A-2 Special Edition addon contains three fully functional 3D virtual cockpits, one for each aircraft model. Virtual cockpits allow for a total 3D immersion into the X-15 flying environment. You must be in the virtual cockpit view ("**F9**" on your keyboard) to operate this addon.

Full-3D cockpits no longer have low-resolution flat 2D gauges. They contain fully modeled high-resolution 3D gauges.

When loading a new flight, make sure you've selected the new X-15A-2 SE addon. The previous version (1.0) had no virtual cockpit. The installer will not erase nor replace the previous software version, if installed on your computer. The new version will be installed in different folders. You may choose to delete or keep the previous version before installing the new version. We suggest deleting the old version.

Does my X-15A-2 SE addon come with 2D panels?

No. Xtreme Prototypes next generation addons no longer include 2D panels found in older products. They are replaced by full-3D virtual cockpits. Full-3D cockpits no longer have low-resolution flat 2D gauges. They contain fully modeled high-resolution 3D gauges. You must be in the virtual cockpit view ("**F9**" on your keyboard) to operate this addon.

Is the X-15A-2 Special Edition addon (version 2.0) an update to your previous X-15A-2 addon (version 1.0)?

No. The X-15A-2 Special Edition v2.0 is a completely redesigned product that features entirely new high-resolution models and textures, highly detailed virtual cockpits with full 3D gauges, additional systems and functionalities, new animations, and new special visual effects and sounds, among many other features. Version 1.0 is now discontinued.

What is the maximum speed of my X-15A-2 SE addon?

The maximum speed of the X-15A-2 SE addon is limited by the simulator to approximately Mach 4.65 on all current platforms. Refer to "Aircraft Reference Information (X-15A-2)".

What is the maximum altitude than can be reached with my X-15A-2 SE addon?

The X-15A-2 SE addon will allow you to reach an altitude of over 300,000 feet on all simulation platforms.

At the time of publication, rocket engines and ballistic control for rocket airplanes were still not supported in either Microsoft® Flight Simulator X or Lockheed Martin® Prepar3D®. Your simulation platform still sees the X-15A-2's XLR-99 engine, and the solid rocket boosters on the X-15AD-4, as jet engines. Rocket-propelled flight is therefore not 100% accurate in the simulator although we tried our best to emulate it as much as we could in the flight model, considering the present limitations. We sincerely hope that all simulation platforms will offer support for rocket engines (and ballistic control) in the near future.

Because aerodynamic control surfaces become less and less effective above about 125,000 feet in the simulator as dynamic pressure decreases, we recommend flying the X-15A-2 addon below 200,000 feet. The simulator will still give you limited control at high altitudes, but flying will become more challenging.

Note that the highest altitude attained by the real X-15A-2 rocket plane was 249,000 feet (August 3, 1966) and that most high speed flights were performed at even lower altitudes.

We found that the best way to complete a ballistic trajectory at high altitude is to level off and maintain heading after the engine is cut off. Eventually, the aircraft will lose altitude until the control surfaces become effective again. For more information about this technique, refer to "The X-15 Experience".

Where's the parabrake?

The X-15 didn't use a parabrake. The aircraft landed on specially designed steel skids that provided adequate deceleration.

Where's the B-52?

There is no B-52 carrier included with the current version of the X-15A-2 SE addon.

Difficult "editorial" decisions need to be made all the time while developing a new product. Of course, we could have modeled a "light" B-52 carrier for our X-15A-2 SE addon (similar to

the B-29 model included with our Bell X-1 SG addon). However, the X-15A-2 SE is a far more complex addon than our X-1 SG. Instead of allowing precious computer resources on what would merely be an "eye candy" in the simulator due to software limitations, we've decided to concentrate our efforts on the actual models, systems and unique features of the X-15A-2 airplane.

The B-29 "carrier" in our X-1 SG addon is purely an extension to the X-1 model. It offers no functionality of its own. In fact, it's the X-1 that is carrying the B-29! While we recognize that it is visually appealing and makes for some nice screenshots, it brings no real added value to serious desktop pilots who are much more interested in learning about the X-15 systems and flying a rocket airplane.

At the time of publication, neither Microsoft® Flight Simulator X nor Lockheed Martin® Prepar3D® was offering the possibility for a single user to fly two mated airplanes (with different engines and flight models) concurrently – with perhaps the exception of the glider, but with some serious limitations. Researching and developing new code to permit for this to happen in the simulator was beyond our resources and the scope of this project. If we decide to offer a B-52 carrier in future versions of our X-15A-2 addon, this would be our approach, should the underlying (simulator) technology allow it.

Can the pilot eject from the aircraft?

No. The ejection seat on the X-15A-2 addon is highly detailed and has some animated features. However, it cannot eject from the cockpit in this software version. Animating and programming the complex ejection method used on the X-15 airplane was beyond the scope of this project.

SOFTWARE INSTALLATION AND SETUP

I have trouble downloading my addon. The file transfer keeps getting interrupted. What can I do?

Normally, it should take no more than about 5

to 15 minutes to download your addon on a high speed Internet connection.

If you don't have a high speed Internet connection, or experience intermittent connection issues, you may be timed out or disconnected while transferring the file. If you are not able to download your addon after several attempts, we recommend using another and better connection either at work (if allowed) or at a parent's or friend's. If you don't have access to another connection, and still cannot solve the issue, please contact us for other options. We recommend using your Internet browser (Internet Explorer, Chrome, etc.) to download your addon. Do not use a third-party download manager or you may experience problems that were reported by a number of users.

Some antivirus programs may also prevent you from downloading your addon. Make sure your antivirus does not interfere with your downloads. Also, some antivirus won't allow you to download "zip" (or ".exe") files. You can disable your antivirus program temporarily (while downloading your addon) to solve this issue. Don't forget to reactivate your antivirus after the file is downloaded.

What are the minimum system requirements for installing the X-15A-2 SE addon?

The X-15A-2 Special Edition is an add-on software package that requires Microsoft® Flight Simulator X with Acceleration Expansion Pack (or Flight Simulator Gold fully installed), Microsoft® Flight Simulator X: Steam® Edition or Lockheed Martin® Prepar3D® to be installed on your computer. The software is not a stand-alone product and cannot be used without the underlying simulation platform. Make sure that your simulation platform has been properly installed according to the instructions provided by the manufacturer.

Xtreme Prototypes addons are designed to take advantage of the new and more powerful personal computer systems that are available today. They require better video cards and more processing power and RAM than other more conventional addons. Increased performance will be noticed on more powerful systems.

Refer to "Minimum System Requirements" in the manual.

How do I install the addon I've purchased?

Refer to "Software Installation" in the manual.

The installer asks for my product activation key. Where do I find it?

Your activation key was issued when you purchased your addon online and was sent to you by email. Please contact us if you did not received your activation key or were unable to download your addon after your order was processed.

Can I re-download my addon if I lose the original file?

Yes. You can download your addon again at any time by logging in to our website. Once you are logged in, on the "Your Account" page, select "Review previous orders", click on your order number, and click the link to download your addon. To protect your account, you may download the file a limited number of times. After that, you will need to contact us if you need the file again.

You can also download only the individual installer(s) needed for your simulation platform (s). When in your account page, select "Download available patches and updates for your addon(s)". Fill in the form with your order number and activation key and select the file (s) you want to download (one file at a time). Click the "Download File" button to download the file.

You can also access our "Downloads" section directly (user account required):

https://xtremeprototypes.com/en/downloads.asp

Once downloaded, save the ZIP file on your computer desktop.

Please note that the replacement of lost downloaded files is not guaranteed. We recommend making an extra copy for your own use and to save it in a safe place along with your personal activation key. Refer to the end-user software license agreement for more details.

I've installed my simulation platform in a custom folder, will the installer detect it?

No, but you can specify the correct folder during the installation process. Refer to "Installing your Addon".

Is the X-15A-2 SE addon compatible with Microsoft® Flight Simulator X?

Yes. The X-15A-2 SE addon is optimized for the latest versions of Microsoft® Flight Simulator X with Acceleration Expansion Pack (or Flight Simulator X Gold fully installed). It is not compatible with FSX with Service Pack 2 alone. You will need to install the Acceleration Expansion Pack in addition to FSX SP2. Make sure that you install the correct addon version for your simulation platform. Refer to "Compatibility, Performance and Settings" for more information.

Is the X-15A-2 SE addon compatible with Microsoft® Flight Simulator X: Steam® Edition?

Yes. The X-15A-2 SE addon is fully compatible with Microsoft® Flight Simulator X: Steam® Edition. A special installer is available from our "Downloads" section (free for registered users).

Please note that FSX: Steam® Edition is installed in a different way to the boxed version and occupies a different location on your computer. With the standard installer for FSX, you will need to specify a different path/root folder during the installation process to deploy the addon into FSX: Steam® Edition (by default: "C:\Program Files (x86) \Steam\steamapps\common\FSX").

Also, with the standard installer, you will need to copy the saved flights from the "C:\Users\your name\Documents\Flight Simulator X Files" folder to your "C:\Users\your

name\Documents\Flight Simulator X - Steam Edition Files" folder. This is because FSX: Steam® Edition uses a different folder to store your saved flights.

For these reasons, we recommend using the special installer for FSX: Steam® Edition.

Refer to "Compatibility, Performance and Settings" for more information.

Is the X-15A-2 SE addon compatible with Microsoft® Flight Simulator 2004?

No. Refer to "Compatibility, Performance and Settings" for more information.

Is the X-15A-2 SE addon compatible with Lockheed Martin® Prepar3D®?

Yes. The X-15A-2 SE is optimized for the latest versions of Lockheed® Martin Prepar3D® v1/v2/v3/v4. Make sure that you install the correct addon version for your simulation platform. Refer to "Compatibility, Performance and Settings" for more information.

Is the addon version for Prepar3D® v2 compatible with Prepar3D® v1 and Flight Simulator X?

No. The version for Lockheed Martin® Prepar3D® v2 is a native version and it is not compatible with Lockheed Martin® Prepar3D® v1 and Microsoft® Flight Simulator X. Make sure that you install the correct addon version for your simulation platform. Refer to "Compatibility, Performance and Settings" for more information.

Is the addon version for Prepar3D® v2 compatible with Prepar3D® v3?

Yes. Refer to "Compatibility, Performance and Settings" for more information.

For optimized performance, we recommend upgrading your simulation platform to the 64-bit Prepar3D® v4 and to use the installer for Prepar3D® v4.

Are the addon versions for Flight Simulator X and Prepar3D® v1 compatible with Prepar3D® version 2/3?

Yes. However, we recommend installing the correct version for your simulation platform to avoid special effect issues and to benefit from the new features in Prepar3D® v2/3. Refer to "Compatibility, Performance and Settings" for more information.

Is the X-15A-2 SE addon compatible with Prepar3D® v4?

Yes. The X-15A-2 Special Edition v2.0 addon now includes a native version (labeled 2.01) for the new 64-bit Prepar3D® v4 simulation platform.

A special installer for Prepar3D® v4 is available from our "Downloads" section on our website. The update is free for registered users.

This updated version contains 64-bit DLLs and will not work in previous versions of Prepar3D® (nor in FSX).

What's new in v2.01 for Prepar3D® v4:

- New 64-bit sound DLL compatible with the new simulation platform

- New special effects optimized for the latest versions of Prepar3D®

- A revised ignition system to solve engine start issues encountered in Prepar3D®

- An improved flight model for better stability at high velocities

- A revised 280-page user manual

All other features are the same as in previous versions.

Refer to "Compatibility, Performance and Settings" for more information.

Are the addon versions for Flight Simulator X and previous versions of Prepar3D® compatible with Prepar3D® v4?

No. Prepar3D® v4 is a 64-bit simulation platform that requires a special version of the X-15A-2 SE addon. Refer to "Compatibility, Performance and Settings" for more information.

How do I install the X-15A-2 SE addon in Prepar3D® v3?

There is no special installer for Prepar3D® v3 available for this addon at this time.

To install this addon in Prepar3D® v3, please use the installer for Prepar3D® v2 and change the path to your simulation platform during installation. The version for Prepar3D® v2 is compatible with Prepar3D® v3.

For optimized performance, we recommend upgrading your simulation platform to the 64-bit Prepar3D® v4 and to use the installer for Prepar3D® v4.

Please note that the versions for Prepar3D® v1 and FSX are compatible with all versions of Prepar3D®, except the 64-bit v4.

Refer to "Compatibility, Performance and Settings" for more information.

Is the X-15A-2 SE addon compatible with Laminar Research® X-Plane®?

No. Unfortunately, we won't be able to complete the X-Plane® version of our X-15A-2 SE addon, as previously announced. Development of the X-15A-2 SE for X-Plane® has been halted and the project is on hold until further notice.

Is this addon compatible with the latest version of Windows®?

Yes. Windows® 10/8.1/8/7 or later is required to install and fly this addon. However, because of issues related to installation and performance, we cannot provide support for this addon if installed under Windows® Vista™ or Windows® XP®. As a rule of thumb, if your

simulation platform is running properly on your computer, and assuming that your computer meets the minimum system requirements, you should be able to install and fly the X-15A-2 SE addon without major issues.

Depending on security settings and permissions in Windows® Vista™, you may not be able to install critical software components (DLLs) and the addon will not work. There is no fix or workaround at this time.

Is this addon compatible with Windows® Vista™, XP®?

No. Windows® 10/8.1/8/7 or later is required in order to install and operate this addon (see "Minimum System Requirements"). We are sorry we cannot support this addon if installed under Windows® Vista™ or Windows® XP®.

Is this addon compatible with the latest version of DirectX®?

Yes. Refer to your simulation platform's manual for more information about the recommended version of DirectX®. However, we found that Flight Simulator X performs better under DirectX® 9. This is not an issue with Prepar3D®. Please note that Prepar3D® v2 and later requires DirectX® 11 (and a DirectX® 11-compatible video card). Refer to "Compatibility, Performance and Settings" for details.

My X-15A-2 SE addon has no cockpit. How can this be possible?

By default, the addon with automatically switch to the virtual cockpit view when the aircraft is loaded. If you still cannot see the virtual cockpit, make sure you are in the virtual cockpit view ("**F9**" on your keyboard). The X-15A-2 SE has no 2D cockpit. Refer to "Full-3D Virtual Cockpits" for details.

Also, make sure you've selected the new X-15A-2 SE v2.0 addon. The previous version (1.0) had no virtual cockpit. The installer will not erase nor replace the previous software version, if installed on your computer. The new version will be installed in different fold-

ers. You may choose to delete or keep the previous version before installing the new version. We suggest deleting the old version.

I've installed my new X-15A-2 SE addon but I only see two aircraft variations in the "Select Aircraft" page. Where are the other variations?

If some X-15A-2 SE aircraft variations are missing and only two airplanes seem to be installed, make sure the "Show all variations" option is selected in the "Select Aircraft" (or "Select Vehicle") page. Refer to "Installing your Addon" for more information.

I hear no cockpit sounds. How can I solve this issue?

Make sure your speakers are turned ON and that the sound volume is properly adjusted on your computer sound system. If you can hear other aircraft sounds such as the engine, the flaps of the landing gear sounds, and you still cannot hear the custom cockpit sounds such as when a switch is clicked or the stable platform is started, it may be because the sound DLL was not installed properly during the installation process. You'll need to reinstall the addon to solve this issue.

If you are using FSX, make sure that you accept installing the sound DLL on your system when asked (you should click "YES" or "RUN" when the dialogs appear in the lower right corner of your Windows® desktop and when starting your simulation platform for the first time after installing the addon). This needs to be done only once.

Please note that Prepar3D® v4 is a 64-bit simulation platform that requires a special new version of the X-15A-2 SE addon. Previous versions will not work in Prepar3D® v4. Please make sure you've installed the correct version for your simulation platform.

Refer to "Installing your Addon" and "Adjusting the Sound Volume" for more information.

Some aircraft parts are missing on both the exterior model and the virtual cockpit. What's wrong?

Try resetting the flight. It this does not solve the issue, it may be because some important software components are missing or were not installed properly during the installation process. Check the About panel, available from the "Views/Instruments" menu item on your simulator's top menu bar, to check if some components are missing. If so, you'll need to reinstall the addon to solve this issue.

If you are using FSX, make sure that you accept installing the addon's system DLL when asked (you should click "YES" or "RUN" when the dialogs appear in the lower right corner of your Windows® desktop and when starting your simulation platform for the first time after installing the addon). This needs to be done only once. Refer to "Installing your Addon" for more information. If you still have the issue after reinstalling the addon, please contact customer support.

How do I remove the X-15A-2 SE addon from my computer?

The X-15A-2 SE addon can be removed from the Windows® Control Panel (Program/Uninstall a Program), like any other program.

Do not use the uninstallation program (uninstall.exe) directly. The uninstallation program is located in the application folder that was created during the installation process and is used by the Windows® Control Panel.

I'm using Flight Simulator X in another language than English. Where are the saved flights? (FSX)

If you are using Flight Simulator X in another language than English, you will need to manually move the saved flights from the "C:\Users*your name*\Documents\Flight Simulator X Files" folder to your "C:\Users*your name*\Documents*Flight Simulator X Files in your language*" folder. This is because Flight Simulator X changes the name of your saved flight folder, depending on your language. For example, while the folder name "Flight Simula-

tor X Files" is used in English, it becomes "Fichiers Flight Simulator X" in French. The installer cannot detect the language of your simulation platform so you will have to copy or move the saved flight files manually. This is not an issue in Prepar3D®.

The aircraft cannot be selected in the "Select Aircraft" page. Why? (FSX)

It's been reported during the beta tests that some third-party addons or FS utilities may interfere with the correct installation of the X-15A-2 SE addon. These programs may also alter the appearance of your add-on aircraft by modifying the textures and the materials in the model files. If the different X-15A-2 aircraft variations are correctly displayed in the "Select Aircraft" page but you are unable to select any one of them, or worse if selecting them causes FSX to crash, suspect such third-party programs. For unknown reasons, these programs may prevent the addon's system DLLs from being "trusted" by FSX and the addon will not work. Remove these programs to solve the issue.

Also, depending on security settings and permissions in Windows® Vista™, you may not be able to install critical software components (DLLs) and the addon will not work. We are sorry we cannot support this addon if installed under Windows® Vista™ or Windows® XP®. Windows® 10/8.1/8/7 is required in order to install and operate this addon (see "Minimum System Requirements").

AIRCRAFT OPERATION AND PROCEDURES

How do I take off and fly my X-15A-2 SE addon?

All the necessary information to fly the X-15A-2 SE addon is in the documentation. There are two sets of instructions: a detailed set, which contains the entire procedures involved in a real X-15A-2 flight (perfect for X-15 fans, beginners and more advanced desktop pilots alike), and a condensed set called "quick-start procedures", for those who want a shorter check list.

If this were not enough, the X-15A-2 SE addon can now be started automatically at the touch of a single "magic" red button, so anyone can take off quickly and easily and fly the beast.

What's the easiest way to start the engine without going through the entire check list and procedures?

The engine can now be started automatically at the touch of a single "magic" red button.

Can I use "CTRL+E" to start the engine?

No. The simulator's autostart command ("CTRL+E") should not be used to start the X-15A-2 engine. For a quick start, use the automatic ignition sequence start button [76, fig. 5-1], located on the main instrument panel, instead. This is similar to pressing "CTRL+E" with conventional aircraft. However, the red button initiates all X-15A-2 rocket aircraft systems, including the special three-propellant fuel management system. Refer to "Custom Fuel Management System" for more information.

Why are some of the aircraft systems reset when a new X-15A-2 SE aircraft is loaded?

Only some systems are reset, but not all. This is because the X-15A-2 addon uses its own proprietary internal variables in addition the simulator's variables. Unfortunately, due to software limitations, these custom variables are not memorized by the simulator between flights. If the panels appear "frozen" after a new aircraft was loaded while in flight, simply end the current flight and start a new flight with the new X-15A-2 aircraft. Note that the correct initialization and ignition sequence procedures (including pressing the "magic" red button, if preferred) must be performed before flight each time a new X-15A-2 aircraft is loaded in the simulator.

The X-15 instrument panels appear "frozen" after a new aircraft was loaded while in flight. What do I do?

This is not likely to happen in this software version, however if it does, simply end the current flight and start a new flight with a new X-15A-2 aircraft. Note that the correct initialization and ignition sequence procedures (including pressing the "magic" red button, if preferred) must be performed before flight each time a new X-15A-2 aircraft is loaded in the simulator.

I just loaded a new flight and I see special effects like APU exhaust steam, but I haven't done anything yet. How do I turn these effects off?

While highly improbable in this software version, if such effects are visible, do the following procedure to turn off the unwanted effects:

1. Press the "**L**" key (the simulator's "All Lights On/Off" command) on your keyboard as necessary, until all effects disappear.

Refer to "Special Visual Effects" for more information.

Why is my X-15A-2 SE addon moving on the runway at the beginning of a new flight?

This should not happen in this software version. Should you encounter this issue at the beginning of a flight, here are a few tips:

By default, the simulator loads the previously saved (or default) flight with the engine of the aircraft running and the parking brake released. In the case of the X-15, it takes a split second for the simulator to "realize" that the rocket aircraft has not been serviced with the necessary propellants and to shut off the engine automatically. Because of the power of the mighty XLR-99 (and the rocket boosters on the X-15AD-4), the initial split second of thrust is enough to move the aircraft along the runway.

(**Did you know?** The XLR-99 engine's second-stage igniter phase by itself produced 1500 pounds of thrust on the real aircraft.)

To avoid this problem, we recommend loading one of the saved flights included with the X-15A-2 SE addon as a "template" for a new flight. This has the advantage of presetting all X-15 internal systems to off and preventing the rocket plane from moving by itself on the runway at the beginning of a flight because the engine was running with the parking brake released in the previous flight, in the last saved flight or in the default flight.

As an alternative, you can also create a new flight with a single-engine stock aircraft (one that comes with the simulator), turn off the engine ("**CTRL+SHIFT+F1**") and set the parking brake ("**CTRL+.**") . Replace the aircraft with the X-15A-2 SE and go to Edwards Air Force Base (or any other runway of your choice) and save this flight under a different name. Simply load this saved flight (or make it your default flight) each time you want to fly the X-15A-2 SE.

Also, make sure the parking brake is set before starting the igniter-idle phase.

Why is my X-15AD-4 addon (with solid rocket boosters) moving on the runway during the igniter-idle phase?

If this happens, make sure the parking brake is set before starting the igniter-idle phase (on some simulation platforms).

(**Did you know?** The XLR-99 engine's second-stage igniter phase by itself produced 1500 pounds of thrust on the real aircraft.)

This is due to the immense power of the three engines combined and to some limitations in the simulator. The igniter-idle phase is in reality the jet engine starting phase that may generate enough thrust to move a small aircraft like the X-15 on the runway if the parking brake is not set.

Why can't I reach the maximum speed/altitude?

If you are using Flight Simulator X, make sure you have the latest version and that the Acceleration Expansion Pack is installed. Refer to "Minimum System Requirements".

The maximum speed of the X-15A-2 SE addon is limited by the simulator to approximately Mach 4.65 on all current platforms. Refer to "Aircraft Reference Information (X-15A-2)".

The X-15A-2 SE addon will allow you to reach an altitude of over 300,000 feet on all simulation platforms.

At the time of publication, rocket engines and ballistic control for rocket airplanes were still not supported in either Microsoft® Flight Simulator X or Lockheed Martin® Prepar3D®. Your simulation platform still sees the X-15A-2's XLR-99 engine, and the solid rocket boosters on the X-15AD-4, as jet engines. Rocket-propelled flight is therefore not 100% accurate in the simulator although we tried our best to emulate it as much as we could in the flight model, considering the present limitations. We sincerely hope that all simulation platforms will offer support for rocket engines (and ballistic control) in the near future.

Because aerodynamic control surfaces become less and less effective above about 125,000 feet in the simulator as dynamic pressure decreases, we recommend flying the X-15A-2 addon below 200,000 feet. The simulator will still give you limited control at high altitudes, but flying will become more challenging.

Note that the highest altitude attained by the real X-15A-2 rocket plane was 249,000 feet (August 3, 1966) and that most high speed flights were performed at even lower altitudes.

We found that the best way to complete a ballistic trajectory at high altitude is to level off and maintain heading after the engine is cut off. Eventually, the aircraft will lose altitude until the control surfaces become effective again. Refer to "The X-15 Experience" for some advice about flying the X-15A-2 SE addon or review the "Normal Procedures".

I've just installed my X-15A-2 SE addon and loaded my first flight but I cannot see the cockpit. What's the problem?

By default, the addon will switch automatically to the virtual cockpit view when the aircraft is loaded at the beginning of a new flight. If you still cannot see the virtual cockpit, make sure you are in the virtual cockpit view ("**F9**" on your keyboard). The X-15A-2 SE has no 2D cockpit. Try cycling the different views by pressing the "**S**" and "**A**" keys on your keyboard until you get the virtual cockpit view. Refer to "Full-3D Virtual Cockpits" for details.

The landing gear won't retract. What do I do?

We suspect your landing gear was damaged during takeoff from the ground because of the strong acceleration (the X-15 is equipped with a powerful rocket engine). The landing gear must be retracted as soon as the aircraft is airborne to avoid it being damaged by excessive speed. Resetting the flight should correct the problem or simply select the "Ignore crashes and damage" option in the simulator's "Settings - Realism" page. Refer to "Compatibility, Performance and Settings" and "Simulation Platform Initial Settings" for more information.

The rocket exhaust plumes are slightly askew; they're all positioned slightly to the left of the actual holes. Is this normal?

The exhaust plume effects are properly positioned. This is a simulator issue on some platforms. We've noticed the same thing depending on the view and the zoom level. Fortunately, it's not always noticeable.

The special visual effects don't look like the ones on your website. What's wrong?

The special visual effects (engine flames, contrails, APU exhaust, etc.) included with your X-15A-2 SE addon should look like the ones shown on the product page and in the documentation.

For reasons that are sometimes hard to define, special effects appearance may vary from system to system, depending on many factors including your simulation platform, your frame rate, your version of DirectX®, your view aspect ratio and your graphics hardware and settings. If, after trying different settings (see "Compatibility, Performance and Settings"), you are still not satisfied with the effects on your system (for example, they are too big or too small), try replacing the special effect files.

Visit the "Downloads" section on our website and download the Special Effects Package. Try the different effects by copying them to your "... *simulator name*\Effects" folder. Read the instructions included with the Special Effects Package.

The special effect engine was changed from CPU to GPU with the release of Prepar3D® v2. This has the advantage of freeing computer resources and improving performance on high-end graphics hardware. The X-15A-2 SE special visual effects were upgraded to conform to the Prepar3D® v2 specifications. While the new Prepar3D® v2 particle effects are visually identical to the FSX/Prepar3D® v1 effects, there is a simulator issue affecting extrusion effects that still needs to be resolved. Until then, extrusion effects such as engine contrails, wing vortices and vaportrails, APU exhaust and propellant jettison effects at high speed and altitude may appear sawtoothed, wrongly oriented, faded, with repeating arrow patterns. This is normal until a fix is made available.

For other reasons, we noticed a similar issue in FSX: Steam® Edition, to a lesser degree. This is normal until a fix is made available.

Please note that these issues are now resolved in the new addon version for Prepar3D® v4.

Refer to "Special Visual Effects" for more details and options.

The SAS control panel pitch, roll, yar and yaw caution lights should come on when the function switches are up. Mine go out and are on when switches are down. What's wrong?

Nothing is wrong. The SAS pitch, roll, yar and yaw caution lights [1-4, fig. 5-2] are amber caution lights that should be ON when the function switches [5-6, 8-9, fig. 5-2] are at OFF and go out when the switches are at ON. Refer to "Stability Augmentation System Controls and Indicators" for details. Note that this applies to most caution lights in the cockpit, except the RAS function lights [10, fig. 5-4] on the left white control box.

Some switches in the virtual cockpit don't work when clicked on. Is this an issue?

No. Refer to "How to Activate the Switches, Buttons, Knobs and Levers". Make sure you have a wheelmouse (refer to "Minimum System Requirements").

I've installed my new X-15A-2 SE addon, and nothing works and I cannot start the engine by all means on any aircraft. Where is the automatic ignition red button on my X-15A-2? Please help!

Reload the flight. Make sure you are in the virtual cockpit view ("**F9**" on your keyboard). Do not press "CTRL-E" to start the engine! Read "Custom Fuel Management System".

It sometimes occurs that the view point in the virtual cockpit was adjusted too far back and lays inside the pilot seat's backrest, rendering the switches unclickable. When this happens, simply move your view point forward a little.

Now press (click) the "magic" red button [76, fig. 5-1] located on the main panel. Be patient, watch the gauges and switches moving and the engine should start automatically in a few seconds.

If you decide to follow the normal procedures or the quick-start procedures, you must make sure that the engine is priming (prime switch [56, fig. 5-1] must stay in the **middle posi-**

tion, not at OFF or down position, after being clicked) and that the turbopump is operating before attempting to fire the engine. If the prime switch cannot be turned **ON** and then spring released to its middle position, something has been done improperly in the previous steps.

When the engine is priming, the green ignition ready light [2a, fig. 5-1] on the left side of the main panel should come **ON**.

Once the engine is priming, press the turbopump button [54, fig. 5-1] once to start the turbopump. When the turbopump is operating, the propellant manifold pressure gauge [51, fig. 5-1] should indicate between 300 to 450 psi (this means that the propellants are fed to the engine).

Then turn the igniter-idle switch [53, fig. 5-1] to **ON** (up position) to fire the spark plugs and ignite stages one and two. The chamber 2 pressure gauge [50, fig. 5-1] should now indicate between 150 to 300 psi and flames should be seen in the main chamber.

Then, when the throttle is moved inboard to **START or 50%**, the main chamber should fire.

One of the best ways to learn about the complex ignition sequence of the X-15 is to follow the quick-start procedures one by one and watch what happens to the pressure gauges after each switch is clicked.

Note: Circuit breakers on the right console are fully functional in the X-15A-2 SE addon. The circuit is closed when the breaker is pushed in. The circuit is open when the breaker is pulled out. Make sure all breakers are pushed in for proper aircraft operation.

Speed brakes and other aerodynamic control surfaces should be inoperable with the APUs off due to lack of hydraulic pressure. Why can I still move them? (FSX, Prepar3D® v1)

We know. This is a software limitation in both FSX and Prepar3D® v1. It is no longer an issue in Prepar3D® v2 and later. The flaps seems to work according to specs on all simulation platforms.

The nose gear should be non-steerable, as the required shimmy damper was not installed to save weight.

We know. However, we thought that our users would appreciate a steerable nose gear on their new addon.

There was no autopilot in the real X-15. The SAS in not working properly. Why?

We know. While there is no X-15-type stability augmentation system available in Microsoft® Flight Simulator X or Lockheed Martin® Prepar3D® (except perhaps for yaw damping), we thought it would be a good idea to provide our users with the basic autopilot modes offered in the simulator instead. The X-15A-2 SE addon contains a modified SAS panel [48, fig. 5-1] with the basic autopilot controls for altitude hold, wing leveling, attitude hold and yaw damping modes. These controls are described in the "Stability Augmentation System Controls and Indicators" section.

The landing gear cannot be retracted by the pilot on the real X-15. Why is the landing gear retractable on the X-15A-2 SE addon?

We know. However, we thought that our users would appreciate a retractable landing gear on their new addon, especially during (fictitious) takeoffs from the ground.

I experience extremely low frame rate while flying the X-15A-2 SE addon. Is this normal?

No. Refer to "Compatibility, Performance and Settings".

Also, we noticed that sometimes, for no apparent reason, the frame rate would drop significantly at the beginning of a new flight in FSX. We believe this to be a simulator issue. If you didn't experienced slow rate issues with the X-15A-2 SE addon before, reset the flight. If the issue is not resolved, refer to "Compatibility, Performance and Settings".

I hear a strange howling sound when positioning the aircraft at high altitude with the map to simulate an X-15 launch. Is this normal?

Yes and no. This is the normal "hog calling" like noise of the X-15 rocket engine being shut down by the addon's special systems. So why was the engine fired in the first place? Because the simulator has the bad habit of starting the engine when positioning the aircraft in mid-air with the map or with the slew commands. In the case of the X-15, which requires special procedures to start the engine, this isn't a good idea. So that's why the addon needs to shut down the engine, which produces this unique sound. This has no other impact on the simulation.

Solid rocket boosters cannot be shut down after ignition. Why can I shut them down on the X-15AD-4 by moving the throttle to OFF?

Some modern solid fuel rocket boosters can be extinguished after they are fired. We know however that this is something the type of boosters installed on the AD-4 could not do. But we needed to provide a way to shut them off to go around the simulator's bad habit of starting the engines when positioning the aircraft in mid-air with the map or with the slew commands. This is why the boosters will shut down if the throttle is moved outboard to **OFF**.

To re-ignite the boosters after they were shut down, you will need to move move the igniter idle switch to **OFF**, then back to **IGNITER**. When the throttle is moved inboard to **START 50%**, the three engines will fire, including the rocket boosters.

I don't like the engine sound on this jet. Why can't I hear the whining noise of the turbines like with other aircraft in the sim?

The XLR-99 is a rocket engine. Except inside the turbopump, it has no rotating parts. So the sound is very different from one would expect from a jet aircraft engine. According to X-15 pilot Milt Thompson, the XLR-99 engine "*...had a very distinct banshee-type sound that was instantly recognizable... from the rumbling of the ignition sequence through the main chamber light off to the peculiar hog calling like noise of the shutdown*". Low frequency noise, rumble and acoustic shock waves were added to the basic sound effect for more realism in the simulation. The "hog calling" like sound upon engine shutoff is an authentic recording of the real XLR-99 engine shutting off. The only whining sounds you will hear in the simulation are those from the engine turbopump, the APUs and the gyroscopes in the stable platform.

I can't turn on the aircraft lights. Where are the switches?

There were no external lights on the real X-15 aircraft. The X-15A-2 SE addon uses available aircraft lights and systems, provided by the simulator, to display special visual effects instead. The only lighting system installed on the X-15 are the cockpit lights that can be turned ON or OFF with the cockpit lighting switch [39, fig. 5-1].

I can't see the tooltips in the virtual cockpit. What's wrong?

If you can't see the tooltips in the virtual cockpit, make sure the "Show cockpit tooltips" option is selected in your simulator's display settings. Refer to "Compatibility, Performance and Settings".

The basic autopilot functions cannot be engaged. Am I missing something?

The SAS power switch (autopilot switch) [78, fig. 5-1] must be at **SAS ON** and the avionics must be turned on for the basic autopilot functions to engage. Refer to "Stability Augmentation System Controls and Indicators". To turn on the avionics, turn the radio on by moving the radio function selector switch [1, fig. 5-8] to the right. If the radio function selector switch is set to **OFF**, the avionics is turned off and the autopilot is disengaged. Refer to "Radio Communication and ADF Controls" for more details.

Why are some basic autopilot functions causing unwanted oscillations at high speed and altitude?

We noticed that some of the simulator's basic autopilot functions such as "wing leveler" and "altitude hold", when engaged, induce unwanted oscillations at very high speed and altitude (instead of helping the pilot). Unfortunately, we have no other solution at this time but to recommend disengaging these functions when such behavior is encountered until a fix is found.

Please note that this issue is now fixed in the new addon version for Prepar3D® v4.

The GPS receiver and the radio-magnetic indicator don't work. Did I forget something?

Make sure the avionics is turned on before using the radio-magnetic indicator and/or the GPS. To turn on the avionics, turn the radio on by moving the radio function selector switch [1, fig. 5-8] to the right. If the radio function selector switch is set to **OFF**, the avionics is turned off and both the GPS and the RMI won't work. Refer to "Radio Communication and ADF Controls" for more details.

I can't see a thing. Why are the windows covered with dirt?

The "dirt" is normal ablator residues resulting from the heat generated during high speed flight on selected aircraft. If you forgot to close the eyelid before a high speed flight, you can **right-click the eyelid handle** to clean ablator splatters from the windows. Refer to "Miscellaneous Equipment".

TROUBLE SHOOTING

I have a number of installation, display and performance issues with my new X-15A-2 SE addon. Could you help me troubleshooting my problems?

If you're experiencing many issues with your new X-15A-2 SE addon, please read carefully the information provided in the "Getting Started" section.

If you still cannot solve your issue(s) after reading the documentation, including the present FAQ section, please consider the followings:

1. **Is your simulation platform running smoothly on your system?** If not, this might be a simulator issue. Please review your installation instructions carefully and reinstall your simulator if necessary.

2. **Did you install the latest service packs for your simulator?** The X-15A-2 SE addon is compatible with Microsoft® Flight Simulator X with Acceleration Expansion Pack (or Flight Simulator X Gold fully installed), Flight Simulator X: Steam® Edition, and Lockheed® Martin Prepar3D® v4/v3/v2/v1 only. Make sure the latest service packs, if any, are installed.

3. **Is the X-15A-2 SE addon the only add-on aircraft installed on your computer that is experiencing or causing the issue(s)?** If not, the addon is not causing the issue(s).

4. **Do you have the latest version of the X-15A-2 SE addon?** Please visit our "Downloads" page to check for new patches or updates for your addon.

5. **Did you install the correct version of the X-15A-2 SE addon for your simulation platform?** Make sure that you install the correct addon version for your simulation platform. Because of differences between simulation platforms, the installers are not interchangeable. Refer to "Package Description".

6. **If you are using FSX SP2, did you install the Acceleration Expansion Pack?** Please install the AEP.

7. **Is your version of DirectX® compatible with your simulation platform and video card?** If you are using FSX/FSX Steam®, uncheck the "DirectX® 10 preview" option box in the FSX "Settings - Display " page. FSX seems to perform better under DirectX® 9. Prepar3D® v2 and later requires DirectX® 11 (and a DirectX® 11-

compatible video card).

8. **If you are using FSX/FSX Steam®, is the "Light bloom" option selected in the FSX display settings page?** While this should not cause an issue in the current software version, try unchecking the "Light bloom" option box in the FSX display settings page. This may also improve your frame rate. Refer to "Recommended Settings for Flight Simulator X".

9. **Can you actually see at least two X-15A-2 SE aircraft in the "Select Aircraft" (or "Select Vehicle") page?** If not, the addon is not installed properly or there is a display or compatibility issue. Refer to "Compatibility, Performance and Settings". Make sure you have the correct settings for your simulation platform.

10. **Can you select/load the X-15A-2 SE aircraft in the simulator (at the start of a new flight)?** If not, the addon is not properly installed or there is a display or compatibility issue. Refer to "Compatibility, Performance and Settings". Also some third-party addons or FS utilities may interfere with the correct installation of the X-15A-2 SE addon. These programs may also alter the appearance of your addon aircraft by modifying the textures and the materials in the model files. If the different X-15A-2 aircraft variations are correctly displayed in the "Select Aircraft" page but you are unable to select any one of them, or worse if selecting them causes FSX to crash, suspect such third-party programs. Remove these programs to solve the issue.

11. **Do you see the X-15A-2 SE aircraft in the spot plane view?** If the addon is properly installed and loaded and you don't see the aircraft in the spot plane view, there is a display or compatibility issue. Refer to "Compatibility, Performance and Settings". Make sure you have the correct settings for your simulation platform.

12. **Do you see the X-15A-2 SE virtual cockpit?** If the addon is properly installed and loaded and you don't see the aircraft in the spot plane view and there is no virtual cockpit, there is a display or compatibility issue. Refer to "Compatibility, Performance

and Settings". Make sure you have the correct settings for your simulation platform. If you see the aircraft in the spot plane view and there is no cockpit, make sure you are in the virtual cockpit view ("**F9**" on your keyboard).

13. **Did you try resetting the flight or reloading the X-15A-2 SE aircraft?** Sometimes, it works.

14. **Did you install the latest service packs for your Windows® operating system?** Make sure your Windows® operating system is up to date. Windows® 10/8.1/8/7 or later is required to install and fly this addon. We are sorry we cannot provide support for this addon if installed under Windows® Vista™ or Windows® XP®.

15. **Did you install the latest driver for your video card (for your operating system)?** Sometimes, it solves display issues.

16. **Did you try tweaking your parameters in the simulator, especially your display settings?** If you experience reduced frame rate, lower your display settings. Reducing the traffic and weather settings may also improve the overall system performance. Refer to "Compatibility, Performance and Settings".

17. **Do you suspect the X-15A-2 SE installer file you downloaded from our website to be corrupted?** You can try downloading the latest version of the software from our website and reinstalling the addon. You will need to login to your user account.

18. **Do you have the minimum system requirements?** You may need a new computer or video card (especially with Prepar3D®). Refer to "Minimum System Requirements".

Note to Prepar3D® v4 Users

The X-15A-2 Special Edition v2.0 addon now includes a native version (labeled v2.01) for the new 64-bit Prepar3D® v4 simulation platform.

A special installer for Prepar3D® v4 is available from our "Downloads" section on our web-

site. The update is free for registered users.

This updated version contains 64-bit DLLs and will not work in previous versions of Prepar3D® (nor in FSX).

What's new in v2.01 for Prepar3D® v4:

- New 64-bit sound DLL compatible with the new simulation platform

- New special effects optimized for the latest versions of Prepar3D®

- A revised ignition system to solve engine start issues encountered in Prepar3D®

- An improved flight model for better stability at high velocities and with the SAS engaged (autopilot)

- A revised 280-page utility flight manual

All other features are the same as in previous versions.

Note to FSX: Steam® Edition Users

The X-15A-2 SE addon is fully compatible with Microsoft® Flight Simulator X: Steam® Edition. A special installer is available from our "Downloads" section (free for registered users).

Please note that FSX: Steam® Edition is installed in a different way to the boxed version and occupies a different location on your computer. With the standard installer for FSX, you will need to specify a different path/root folder during the installation process to deploy the addon into FSX: Steam® Edition (by default: "C:\Program Files (x86)\Steam\steamapps\common\FSX").

Also, with the standard installer, you will need to copy the saved flights from the "C:\Users\your name\Documents\Flight Simulator X Files" folder to your "C:\Users\your name\Documents\Flight Simulator X - Steam Edition Files" folder. This is because FSX: Steam® Edition uses a different folder to store your saved flights.

For these reasons, we recommend using the special installer for FSX: Steam® Edition.

TECHNICAL SUPPORT AND CONTACT INFORMATION

I have another question about my X-15A-2 SE addon, can I contact you?

For technical support, please use our technical support request form:

https://xtremeprototypes.com/en/shopcustcontactsupport.asp

Make sure all the fields in the form are filled out correctly and provide us with as much information as possible about your technical issue. We make every attempt to reply within one business day.

How do I get product patches and upgrades?

Please login to your account on our website. Then visit our "Downloads" section and follow the instructions:

https://xtremeprototypes.com/en/downloads.asp

I have some ideas about improving the X-15A-2 SE addon, or about future exciting addons. Can I contact you?

Yes. We'll be most happy to hear from you. Please use our general contact form:

https://xtremeprototypes.com/en/shopcustcontact.asp

I was involved in the real X-15 program during the 1960s and I would be interested in helping you improving this addon. Can I contact you?

Yes. It will be an honor to hear from you. Please use our general contact form:

https://xtremeprototypes.com/en/shopcustcontact.asp

KNOWN ISSUES

APPENDIX 11

As it is always the case with computer software, and especially with addons to existing third-party platforms over which there is limited control, there are some known issues with the current addon version, depending on which simulation platform you are using. Some of these issues are related to the simulator, in which case there is little that can be done from our side, except going around them and expect a fix in the near future. Other issues are related to the addon itself, in which case we are working hard to get them resolved.

We appreciate constructive feedback from our users, so please don't hesitate to report any issue or bug you might have experienced when flying the X-15A-2 SE addon.

To report issues, please fill out our technical support request form:

https://xtremeprototypes.com/en/shopcustcontactsupport.asp

Please make sure that all the required fields in the form are filled out correctly and provide us with as much information as possible about your technical issue.

Because there are as many computer systems as they are users, you may or may not experience the following issues depending on:

- Your computer and graphics hardware

(and settings)

- Your operating system (and settings)

- Your version of DirectX®

- Your simulation platform (and settings)

- Your X-15A-2 SE addon version (including patches and updates, if any)

The X-15 moves on the runway at the beginning of a new flight

This is a known simulator issue but it probably won't happen with this software version.

By default, the simulator loads the previously saved (or default) flight with the engine of the aircraft running and the parking brake released. In the case of the X-15, it takes a split second for the simulator to "realize" that the rocket aircraft has not been serviced with the necessary propellants and to shut off the engine automatically. Because of the power of the mighty XLR-99 (and the rocket boosters on the X-15AD-4), the initial split second of thrust is enough to move the aircraft along the runway if the parking brake is not set.

(**Did you know?** The XLR-99 engine's second-stage igniter phase by itself produced 1500 pounds of thrust on the real aircraft.)

To avoid this problem, we recommend loading one of the saved flights included with the X-15A-2 SE addon as a "template" for a new flight. This has the advantage of presetting all X-15 internal systems to off and preventing the rocket plane from moving by itself on the runway at the beginning of a flight because the engine was running with the parking brake released in the previous flight, in the last saved flight or in the default flight.

As an alternative, you can also create a new flight with a single-engine stock aircraft (one that comes with the simulator), turn off the engine ("**CTRL+SHIFT+F1**") and set the park-

ing brake ("**CTRL+.**") . Replace the aircraft with the X-15A-2 SE and go to Edwards AFB (or any other runway of your choice), set the parking brake, and save this flight under a different name. Simply load this saved flight (or make it your default flight) each time you want to fly the X-15A-2 SE.

The engine is running at the beginning of a new flight and before the aircraft was serviced

While highly improbable in this software version, if the engine was not shut down automatically by the X-15 integrated systems after the flight was loaded, simultaneously press the "**CTRL+SHIFT+F1**" keys on your keyboard to shut down the engine and apply the brakes to stop the aircraft on the runway. Set the parking brake (**"CTRL+."**) after the aircraft has stopped moving.

To avoid this problem, we recommend loading one of the saved flights included with the X-15A-2 SE addon as a "template" for a new flight. This has the advantage of presetting all X-15 internal systems to off and preventing the rocket plane from moving by itself on the runway at the beginning of a flight because the engine was running with the parking brake released in the previous flight, in the last saved flight or in the default flight.

As an alternative, you can also create a new flight with a single-engine stock aircraft (one that comes with the simulator), turn off the engine ("**CTRL+SHIFT+F1**") and set the parking brake ("**CTRL+.**") . Replace the aircraft with the X-15A-2 SE and go to Edwards AFB (or any other runway of your choice), set the parking brake, and save this flight under a different name. Simply load this saved flight (or make it your default flight) each time you want to fly the X-15A-2 SE.

Unwanted special effects at the beginning of a new flight and before the aircraft has been serviced

While highly improbable in this software version, if such effects are visible, perform the following procedure to turn off the unwanted effects:

1. Press the "**L**" key (the simulator's "All Lights On/Off" command) on your keyboard as necessary, until all effects disappear.

Refer to "Special Visual Effects" for more information.

Windows® security warning dialogs while installing the software or starting the simulation platform (FSX/FSX Steam®)

In addition to many other files, important software components need to be installed on your system for the X-15A-2 SE addon to function. These are contained in special software libraries called DLLs that are copied to the addon's panel folder during the installation process. You must answer YES (or RUN) when asked by Windows® or your simulation platform if you trust these modules and allow them to be installed and to run on your computer.

Standard Windows® security warning dialogs will appear on your desktop and in your simulator's main window the first time your run your simulation platform after installing the X-15A-2 SE addon. Click the "**YES**" button (or the "**RUN**" button) when these dialogs appear. The dialogs will appear only once.

IMPORTANT: The X-15A-2 SE addon will not work without these modules. You must allow them to be installed. Refer to "Software Installation".

Some cockpit sounds can be heard from the external views or when the simulation is paused

In addition to the basic aircraft sounds that are controlled by the simulator's own sound engine, the X-15A-2 SE addon features more than 50 extra sound effects, mainly cockpit sounds, that are managed by the addon's special systems and played by a third-party sound module. Due to software limitations, some cockpit sounds can still be heard from the external views or when the simulator is paused. Volume adjustment in the simulator has no effect on these sounds (see next topic below). This has no impact on the overall simulation.

No volume control to adjust cockpit sounds

While we took great care to adjust the extra cockpit sound effects individually so they fit well in the overall sound mix, there is no separate control to adjust the volume of the extra cockpit sounds in this software version. This is mainly due to limitations in the current simulation platforms. However, it is possible to balance the extra cockpit sounds with the basic aircraft sounds that are controlled by the simulator by using the master volume control of your computer sound system. First, adjust the master volume on your computer so that the cockpit sounds are at a correct level. Cockpit sounds can be heard by clicking some of the switches, levers and knobs in the virtual cockpit. Then adjust the basic aircraft sounds in the "Settings – Sound" page, under "Volume Levels" for the proper balance. This has no impact on the overall simulation and needs to be done only once.

"Blue texture flashes" on exterior and interior models, before the addon textures are loaded (FSX/FSX Steam®)

This is a simulator issue. If you experience "blue texture flashes" in FSX while the addon textures are loading, especially when in the virtual cockpit, we recommend disabling the DirectX® 10 Preview option in your Display settings (Graphics tab). FSX seems to perform better under DirectX® 9. Third-party free DirectX® 10 shader fixers are also available in FSX forums. Note that a small delay (especially on slower computer systems) before the addon textures are loaded is normal on the current simulation platforms, especially when loading high-resolution textures. For more information, refer to "Recommended Settings for Flight Simulator X".

The special visual effects don't look like the ones shown in the documentation

The special visual effects (engine flames, contrails, APU exhaust, etc.) included with your X-15A-2 SE addon should look like the ones shown on the product page and in the documentation.

For reasons that are sometimes hard to define, special effects appearance may vary from system to system, depending on many factors including your simulation platform, your frame rate, your version of DirectX®, your view aspect ratio and your graphics hardware and settings. If, after trying different settings (see "Compatibility, Performance and Settings"), you are still not satisfied with the effects on your system (for example, they are too big or too small), try replacing the special effect files.

Visit the "Downloads" section on our website and download the Special Effects Package. Try the different effects by copying them to your "... *simulator name*\Effects" folder. Read the instructions included with the Special Effects Package.

Refer to "Special Visual Effects" for more details and options.

Please note that this is no longer an issue with the new addon version for Prepar3D® v4.

Some special visual effects don't look like the ones shown in the documentation (Prepar3D® v2/3 with DirectX® 11, FSX: Steam® Edition)

This is a simulator issue that is purely cosmetic and has no impact on the overall simulation.

The special effect engine was changed from CPU to GPU with the release of Prepar3D® v2. This has the advantage of freeing computer resources and improving performance on high-end graphics hardware. The X-15A-2 SE special visual effects were upgraded to conform to the Prepar3D® v2 specifications. While the new Prepar3D® v2 particle effects are visually identical to the FSX/Prepar3D® v1 effects, there is a simulator issue affecting extrusion effects that still needs to be resolved. Until then, extrusion effects such as engine contrails, wing vortices and vaportrails, APU exhaust and propellant jettison effects at high speed and altitude may appear sawtoothed, wrongly oriented, faded, with repeating arrow patterns. This is normal until a fix is made available.

For other reasons, we noticed a similar issue in FSX: Steam® Edition, to a lesser degree. This

is normal until a fix is made available.

Please note that this is no longer an issue with the new addon version for Prepar3D® v4.

Refer to "Special Visual Effects" for more details and options.

The font used in the system monitor panel appear jagged under DirectX® 9 in FSX and Prepar3D® v1

This seems to be a minor simulator issue. Fonts appear normal under DirectX® 9. We don't know of any fix at this time. This is not an issue in Prepar3D® v2 and later.

The aircraft systems are reset when a new X-15A-2 SE aircraft is loaded?

This is a simulator issue. Some systems are reset, but not all. This is because the X-15A-2 addon uses its own proprietary internal variables in addition the simulator's variables. Unfortunately, due to software limitations, these custom variables are not memorized by the simulator between flights.

If the panels appear "frozen" after a new aircraft was loaded while in flight, simply end the current flight and start a new flight with the new X-15A-2 aircraft. Note that the correct initialization and ignition sequence procedures must be performed before flight each time a new X-15A-2 SE aircraft is loaded in the simulator.

Rocket-propelled flight characteristics are not accurate in the simulator

At the time of publication, rocket engines were still not supported in either Microsoft® Flight Simulator X or Lockheed Martin® Prepar3D®. Your simulation platform still sees the X-15A-2's XLR-99 engine, and the solid rocket boosters on the X-15AD-4, as jet engines. Rocket-propelled flight is therefore not 100% accurate in the simulator although we tried our best to emulate it as much as we could in the flight model, considering the present limitations. We sincerely hope that all simulation platforms will offer support for

rocket engines (and ballistic control) in the near future.

No ballistic control at high altitude

At the time of publication, ballistic control for rocket airplanes was still not supported in either Microsoft® Flight Simulator X or Lockheed Martin® Prepar3D®.

We sincerely hope that all simulation platforms will offer support for rocket engines (and ballistic control) in the near future.

Because aerodynamic control surfaces become less and less effective above about 125,000 feet in the simulator as dynamic pressure decreases, we recommend flying the X-15A-2 addon below 200,000 feet. Note that the highest altitude attained by the real X-15A-2 rocket plane was 249,000 feet (August 3, 1966) and that most high speed flights were performed at even lower altitudes. The simulator will still give you limited control at high altitudes, but flying will become more challenging.

We found that the best way to complete a ballistic trajectory at high altitude is to level off and maintain heading after the engine is cut off. Eventually, the aircraft will lose altitude until the control surfaces become effective again. For more information about this technique, refer to "The X-15 Experience".

Fire extinguishing can be performed only once during a flight

Due to software limitations in the simulator, fire extinguishing can be performed only once during a flight. The flight should be reset or a new flight initiated for the simulator's extinguisher to recharge.

Speed brakes and other aerodynamic control surfaces (except the flaps) are operable with the APUs off and no hydraulic pressure (FSX and Prepar3D® v1)

This is a simulator issue in both FSX and Prepar3D® v1. It is no longer an issue in Prepar3D® v2 and later. The flaps seems to

work according to specs on all simulation platforms.

Basic autopilot functions are causing unwanted oscillation at high Mach numbers

We noticed that some of the simulator's basic autopilot functions such as "wing leveler" and "altitude hold", when engaged, induce unwanted oscillations at very high speed and altitude (instead of helping the pilot). Unfortunately, we have no other solution at this time but to recommend disengaging these functions when such behavior is encountered until a fix is found.

Please note that this is no longer an issue with the new addon version for Prepar3D® v4.

Extremely low frame rate when starting a new flight (FSX)

We noticed that occasionally, and for no apparent reason, the frame rate would drop significantly at the beginning of a new flight in FSX. This would be clearly noticeable in the virtual cockpit. Of course, this is not normal and we believe it is a simulator issue, not an addon issue. It may occur when many changes are made at the beginning of a new flight, like changing the time and season and switching aircraft several times. If you didn't experienced slow rate issues with the X-15A-2 SE addon before, simply reset the flight. If the issue is still not resolved, refer to "Compatibility, Performance and Settings".

Strange howling sound when positioning the aircraft at high altitude with the map to simulate an X-15 launch

This is the normal "hog calling" like noise of the X-15 rocket engine being shut down by the addon's special systems. So why was the engine fired in the first place? Because the simulator has the bad habit of starting the engine when positioning the aircraft in mid-air with the map or with the slew commands. In the case of the X-15, which requires special procedures to start the engine, this isn't a good idea. So that's why the addon needs to shut down the engine, which produces this unique sound. This has no other impact on the simulation.

Some aircraft parts are missing on the exterior model after loading a saved flight from the Free Flight page (FSX)

This simulator issue has been resolved during the beta tests. However, if some parts on the external model are missing after loading a saved flight from the Free Flight page in FSX with the same aircraft that appear in the aircraft preview window, resetting the flight will return things to normal. Loading the same flight from the top menu bar did not create any issue so we don't know at this time what might have cased this anomaly.

The ball nose is moving while the aircraft is sitting on the runway, making the needles on some instruments go crazy

It is normal to see the ball nose moving in the direction of the wind, but not in an exaggerated manner. This seems to be a simulator issue that cannot be resolved at this time. The effect disappears when the aircraft is airborne. This affects the ball nose and the angle-of-attack and side-slip indicators in the cockpit. There is no fix at this time.

Saved flights are missing when using Flight Simulator X in another language than English (FSX)

If you are using Flight Simulator X in another language than English, you will need to manually move the saved flights from the "C:\Users*your name*\Documents\Flight Simulator X Files" folder to your "C:\Users*your name*\Documents*Flight Simulator X Files in your language*" folder. This is because Flight Simulator X changes the name of your saved flight folder, depending on your language. For example, while the folder name "Flight Simulator X Files" is used in English, it becomes "Fichiers Flight Simulator X" in French. The installer cannot detect the language of your simulation platform so you will have to copy or move the saved flight files manually. This is

not an issue in Prepar3D®.

Setting the local time with the clock produces unexpected results, including freezing the screen (FSX)

Setting the local time with the aircraft clock sometimes produces unexpected results in FSX, including freezing the screen while the simulator is updating the environment and traffic. If you experience such an issue on your simulation platform, we recommend changing the local time on the "SELECT TIME AND SEASON" page in the simulator (available from the "World" menu item in the top menu bar) instead. This seems to be a minor simulator issue and we don't know of any fix at this time. We did not encounter this issue in Prepar3D®.

The landing gear is buried into the ground or floats above it when the aircraft lands on some terrains

The landing gear is configured so it (and the aircraft) sits properly on the ground on most hard surfaces such as a concrete runway or a dry lakebed. However, it is normal for the landing gear to be partially buried into the ground or even to "float" above it if you land the aircraft on a rough, soft (sandy) or uneven terrain, for example, after an emergency landing somewhere in the desert. This also depends on the resolution of the mesh on which it sits. It all cases, this is a terrain issue and not an addon issue.

The rear skids sink into the ground during takeoff

The X-15 was not designed for a normal takeoff from the ground. Because of the position of the rear landing gear relative to the center of gravity, it is normal for the rear skids to sink slightly into the ground for a brief moment when the airplane takes off, especially if you pull back too much on the center stick.

The aircraft cannot be selected in the "Select Aircraft" page, FSX crashes (FSX)

It's been reported during the beta tests that some third-party addons or FS utilities may interfere with the correct installation of the X-15A-2 SE addon. These programs may also alter the appearance of your add-on aircraft by modifying the textures and the materials in the model files. If the different X-15A-2 aircraft variations are correctly displayed in the "Select Aircraft" page but you are unable to select any one of them, or worse if selecting them causes FSX to crash, suspect such third-party programs. For unknown reasons, these programs may prevent the addon's system DLLs from being "trusted" by FSX and the addon will not work. Remove these programs to solve the issue.

Also, depending on security settings and permissions in Windows® Vista™, you may not be able to install critical software components (DLLs) and the addon will not work. We are sorry we cannot support this addon if installed under Windows® Vista™ or Windows® XP®. Windows 10/8.1/8/7 is required in order to install and operate this addon (see "Minimum System Requirements").

The addon cannot be installed in Flight Simulator X: Steam® Edition

Please do not use the standard installer for FSX! A special installer for FSX Steam® is available from our "Downloads" section.

Please note that FSX: Steam® Edition is installed in a different way to the boxed version and occupies a different location on your computer. With the standard installer for FSX, you will need to specify a different path/root folder during the installation process to deploy the addon into FSX: Steam® Edition (by default: "C:\Program Files (x86)\Steam\steamapps\common\FSX").

Also, with the standard installer, you will need to copy the saved flights from the "C:\Users\your name\Documents\Flight Simulator X Files" folder to your "C:\Users\your name\Documents\Flight Simulator X - Steam Edition Files" folder. This is because FSX: Steam® Edition uses a different folder to store your saved flights.

For these reasons, we recommend using the new installer for FSX: Steam® Edition. Refer to "Installing your Addon" for more information.

Main instrument panel (Prepar3D® v2 screenshot).
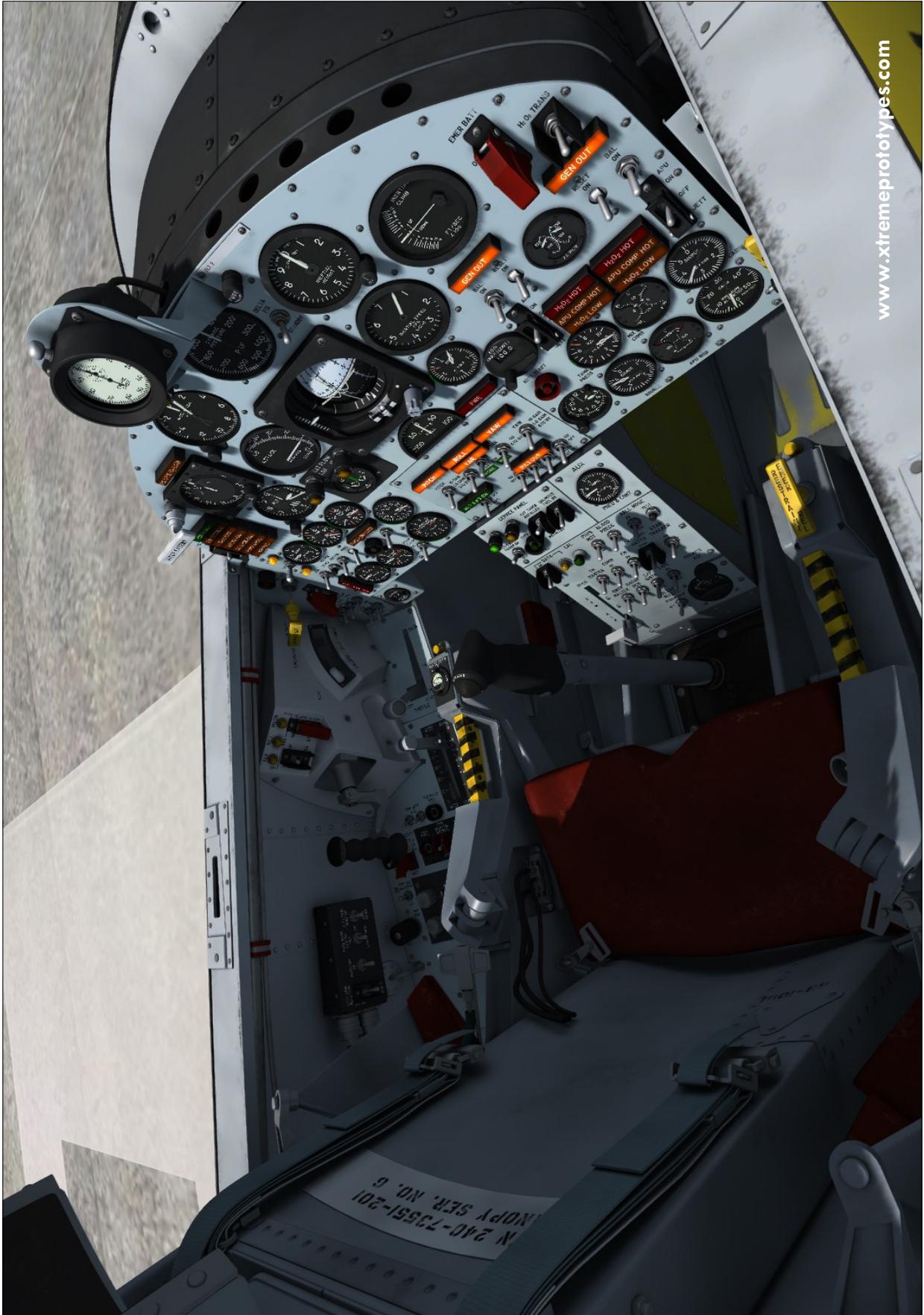
Cockpit left side (Prepar3D® v2 screenshot).

Cockpit right side (Prepar3D® v2 screenshot).

X-15AD-4 (*Prepar3D® v2 screenshot*).

X-15AD-4 in flight (Flight Simulator X screenshot).

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X-15AD-4 in flight (Prepar3D® v4.1 screenshot).

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X-15AD-4 in flight (Prepar3D® v4.1 screenshot).

The mighty XLR-99 engine installed on the X-15A-2 (Flight Simulator X screenshot).
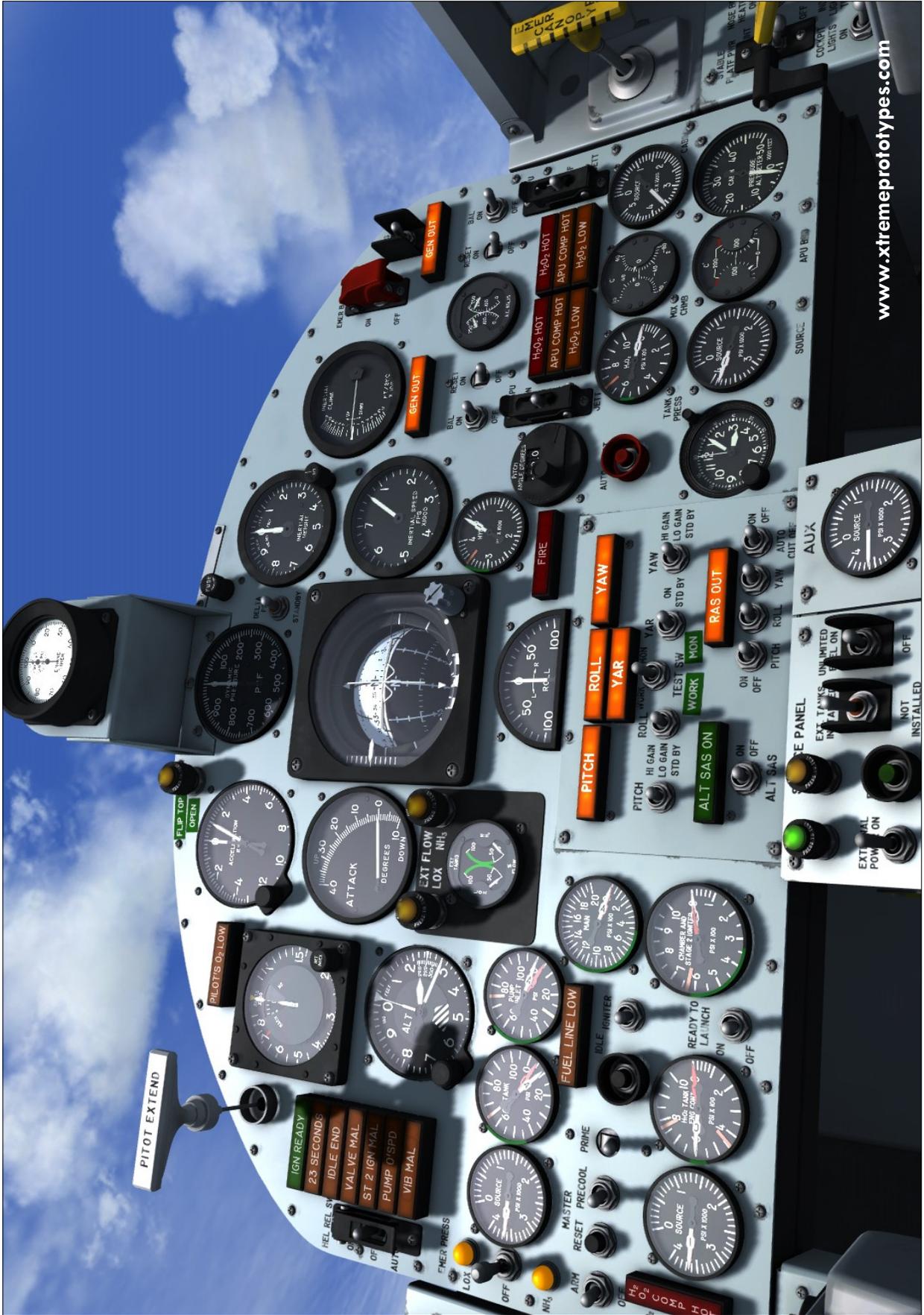
Main instrument panel (Prepar3D® v2 screenshot).

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