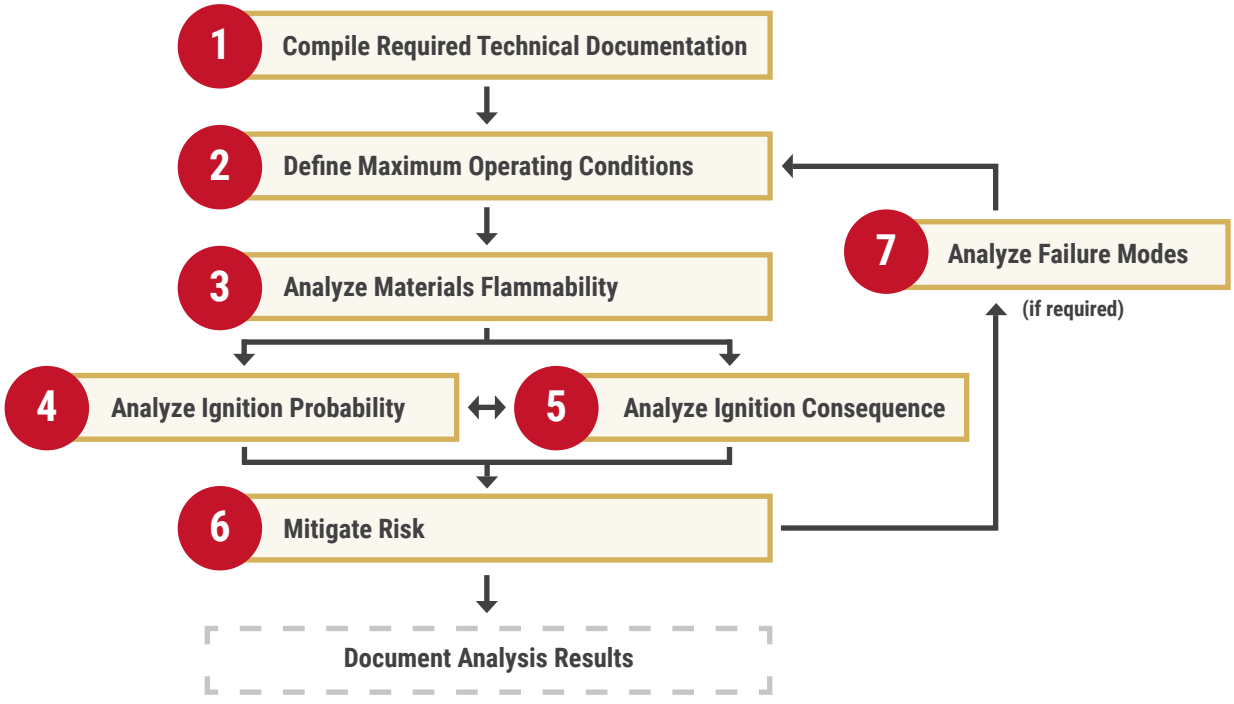
OXYGEN HAZARD ANALYSIS OVERVIEW.

Ignition and combustion hazards are present in all oxygen and oxygen-enriched systems, and fires have occurred in nearly every industry that uses oxygen. Materials become more flammable with increasing oxygen concentrations and pressures, and the energy required to ignite these materials is reduced. A proper analysis of the hazards and fire risk is critical to avoiding fires and ensuring the safety of personnel and equipment.

This document outlines WHA International's basic approach to oxygen hazard analysis. This method is based on the work of WHA engineers with **ASTM International Committee G04**, employing their extensive experience in oxygen system design, testing, and forensic investigation of oxygen fires. This approach has now become standard methodology throughout many industries. It is consistent with the requirements for performing oxygen hazard analyses as presented in **ASTM Standards G-88**, **G-63**, **and G-94** as well as **CGA G-4.4/EIGA IGC 13-12**, **NASA TM-2007-213740**, **NFPA 53**, and others.



For Step 1, all system or component documentation is compiled. This can include piping and instrumentation diagrams (P&ID's), schematics, isometrics, component cross-sectional drawings, materials specifications, cleanliness specifications, and operating conditions.

In Step 2, the maximum operating conditions are determined based on the normally-expected highest pressure, temperature and flow rates.

In Step 3, the flammability of the materials of construction are analyzed based on standard materials oxygen test data and the maximum operating conditions of the application identified in Step 2.

Once the material flammability is determined, both ignition probability and ignition consequence can be analyzed. These are shown as parallel steps (Steps 4 and 5, respectively) because they are independent analysis considerations, and the result of one does not affect the other. This is consistent with general risk analysis methodology where the probability of an event is analyzed independent of the consequence of the event.

For Step 4, ignition probability is analyzed based on the presence of standard characteristic elements assigned to each ignition mechanism.

For Step 5, ignition consequence is analyzed based on the potential fire propagation paths (kindling chains) and associated effects.

Step 6 involves risk mitigation through applying changes to materials, design, procedures, or barrier protection.

Finally, if required, **Step 7** re-applies the hazards analysis approach considering credible single-point failure modes. Often, failure modes can increase the severity of the maximum operating conditions (e.g., relief valve failing closed), which can then change the results of all subsequent steps in the analysis.

MORE ABOUT RISK MITIGATION.

After considering the **steps 1 through 5**, potential hazards may be identified that would present unacceptable risk.

Further steps may be necessary to mitigate or reduce ignition probability and/or ignition consequence to tolerable levels. These measures can include **materials changes**, component or system **design changes**, operating or maintenance **procedure changes**, or protecting personnel and equipment with **barriers or providing remote operation**.

HOW WE CAN HELP.

WHA uses innovative, data-driven tools to help clients understand, evaluate, and mitigate the risks associated with oxygen. Our expertise is based on over 30 years of testing and failure analysis experience. We're specially qualified to work with everything from large bulk storage systems to small medical oxygen components.

HAZARD ANALYSIS.

Our experienced engineers are available to provide several levels of hazard analysis consulting to fit your unique needs. Our state of the art **test facility** is equipped to perform any necessary materials and component testing.

TECHNICAL TRAINING.

We also provide multiple levels of technical training to help your staff better understand the hazards associated with oxygen. Our **Level 4: O2 Analyze** course provides the training your personnel need to perform oxygen hazard analysis on their own.

CONTACT US TO SCHEDULE A FREE CONSULTATION.