TAMPEREEN AMMATTIKORKEAKOULU
Kone- ja tuotantotekniikka
Lentokonetekniikka

Tutkintotyö

Antti Ojanen

EUROSTAR EV-97:N RAKENTAMINEN

Työn ohjaaja Simo Marjamäki

Työn teettäjä Tampereen ammattikorkeakoulu

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TIIVISTELMÄ

Eurostar-projekti alkoi syksyllä 2004, jolloin päätettiin hankkia TAMK Ilmailukerholle ultrakevyt lentokone ja rakentaa se oppilastyönä rakennussarjasta. Eurostar-tyyppiin päädyttiin muun muassa siksi että kyseessä on perinteisesti niitatulla alumiinirakenteella rakennettu kone, jonka rakentamisessa voidaan hyödyntää paikallisesti saatavilla olevaa ammattitaitoa. Valintakriteerinä oli myös se, että kyseessä oleva konetyyppi on maailmanlaajuisesti suhteellisen yleinen ja Suomessa jo tyyppihyväksytty malli. Koneesta pyrittiin tekemään mahdollisimman suuri osa oppilastyönä. Projekti herätti mielenkiintoa myös lehdistössä. Kone rakennettiin Tampereen ammattikorkeakoulun tiloissa vuosina 2005 - 2006.

Työn tarkoituksena on kertoa omalta osaltani koneen rakentamisesta ja projektin kulusta. Työssä pyrin kirjaamaan tietoa ja omia havaintojani lentokoneen rakentamisesta jotka saattavat olla hyödyksi tulevien projektien toteuttamisessa.

TAMPERE POLYTECHNIC
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ABSTRACT

Project Eurostar was initiated in autumn 2004, when it was decided to acquire an ultralight airplane for TAMK aviation club. From the start it was clear that the plane would be built as student work. This type of airplane was chosen because it is of traditional riveted construction and so we could use local experts if needed. Decision was also based on that the EV-97 is globally common ultralight airplane. The airplane was built in TAMK facilities during years 2005 - 2006.

The scope of this work is to describe those phases of the Eurostar EV-97 project that I participated in. Most of my participation was during the early stages of the project, visiting the Evektor factory in Czech Republic and in assembling the wings, flaps and ailerons.

In this work I describe the assembling of the airplane and try to collect information and my own views about this project.

ALKUSANAT

Kiitokset kaikille Eurostar-projektiin tavalla tai toisella osallistuneille. Työmme ei todellakaan mennyt hukkaan koska kone lentää! Kiitokset myöskin Patria Aviationille Jämsään suuresta määrästä ammatillista opastusta, niittauskurssista ja monesta lainatusta työkalusta. Ilman niitä projekti olisi muodostunut hankalammaksi ja kalliimmaksi.

Erityiskiitokset niittausryhmälle 2.

Antti Ojanen

SISÄLLYSLUETTELO

Käytettyjä lyhenteitä ja termejä

CAS	Calibrated Air Speed, korjattu ilmanopeus
VFR	Visual Flight Rules, näkölentosäännöt
Rotax	Itävaltalainen moottorivalmistaja, valmistajan moottorit ovat lähes standardina UL-koneissa. Nykyään Bombardier-Rotax, osa pääosin kanadalaista Bombardier-konsernia.
UL-lentokone	ultrakevyt lentokone (ultralight), ultra
Ultra-A	moottoroitu painopisteohjattu riippuliidin
Ultra-B	ohjainpinnoilla ohjattava ultrakevyt lentokone
Kevytilmailu	Suomen kieleen luotu ultralight-ilmailua tarkoittava termi
satiainen	Cleco, levyosien yhdessä pitämiseen tarkoitettu työkalu
Emfimastic	koneen kokoamisessa käytetty polyuretaanipohjainen tiivisteliima

1. JOHDANTO

Eurostar-projekti alkoi syksyllä 2004, jolloin päätettiin hankkia TAMK Ilmailukerholle ultrakevyt lentokone ja rakentaa se oppilastyönä rakennussarjasta. Eurostar-tyyppiin päädyttiin muun muassa siksi että kyseessä on perinteisesti niitatulla alumiinirakenteella rakennettu kone, jonka rakentamisessa voidaan hyödyntää paikallisesti saatavilla olevaa ammattitaitoa. Valintakriteerinä oli myös se, että kyseessä oleva konetyyppi on maailmanlaajuisesti suhteellisen yleinen ja Suomessa jo tyyppihyväksytty malli.

Rakennusprojektia suunniteltiin sillä periaatteella että mahdollisimman suuri osa koneesta kootaan oppilastyönä. Projekti herätti mielenkiintoa myös lehdistössä. Kone rakennettiin Tampereen ammattikorkeakoulun tiloissa vuosina 2005 - 2006.

Tässä työssä käsittelen niitä vaiheita Eurostar EV-97:n valmistamisessa, joihin olin osallisena. Eniten osallistuin projektin alkuvaiheisiin: tehdaskäyntiin Evektorilla ja siiven sekä ohjainpintojen rakentamiseen. Nämä työvaiheet käsittivät enimmäkseen perinteistä lentokoneenrakennusta niittaamalla. Projektin loppupuolta, loppukokoonpanoa ja ensilentoa, seurasin sivusta kiinnostuneena.

2. ULTRAKEVYEN LENTOKONEEN KÄSITTEET, MÄÄRITELMÄT JA VAATIMUKSET

Ultralight-koneet tulivat käyttöön 1970-luvun lopulla, jolloin ne olivat useimmiten 2-tahtimoottorilla varustettuja painopisteohjattuja riippuliitimiä. Tätä luokkaa kutsutaan Suomessa nimellä Ultra-A. Näiden osuus on Suomessa nykyään noin 20 % rekisteröidyistä ultrista. 1980-luvun alussa tuli kuvaan mukaan ”oikean” lentokoneen näköinen ohjainpinnoilla ohjattava nk. Ultra-B -lentokone. 1990-luvulla ultrissa alettiin siirtyä nelitahtimoottoreihin, jolloin koneiden suoritusarvot ja luotettavuus paranivat huomattavasti.

Kuva 1 Painopisteohjattu Ultra-A -luokan ultrakevyt lentokone /8/

Ultrakevyeksi lentokoneeksi määriteltävä lentokone saa olla korkeintaan kaksipaikkainen, ja kaksipaikkaisena se saa painaa tankattuna ja miehistöineen pyörävarustuksella korkeintaan 450 kg ja kellukeversiona 495 kg (1-paikkaiset 300 kg ja vesikoneena 330 kg). Ultrakevyen lentokoneen tyhjämassa on yleensä 270 - 290 kg. Tästä alhaisesta painosta on suomen kieleen luotu termi kevytilmailu. Toinen rajoitus on, että näillä koneilla saa lentää vain näkölentosäännöissä (VFR) eli päivällä ja hyvällä säällä. Ultrakevyen lentokoneen sakkausnopeus saa olla korkeintaan 65 km/h CAS. Ultrakevyet lentokoneet eivät ole taitolentokelpoisia. /3/

Ultran lentämiseen tarvitaan lupakirja, joka on vaatimuksiltaan yksityislentäjän lupakirjaa helpompi. Luvan hakijan tulee olla vähintään 17-vuotias. Siihen vaaditaan 48 tuntia teoriaopiskelua ja vähintään 20 lentotuntia. Lentäjän terveysvaatimukset ovat samat kuin yksityislentäjän lupakirjassa. Lupakirja on voimassa viisi vuotta kerrallaan. /4/

Ultrakevyitä lentokoneita kuulee joskus moitittavan onnettomuusherkiksi, ja niiden vakuutusmaksutkin ovatkin kohtuullisen korkeat. Osittain tämä huono maine saattaa johtua aiemmin yleisesti käytettyjen kaksitahtimoottorien epäluotettavuudesta. Suomessa ultrakevyille lentokoneille sattuu keskimäärin yksi lentovaurio tuhatta lentotuntia kohden, mikä on noin kolminkertainen yksimoottorisiin yleisilmailukoneisiin nähden. Osa tästä saattaa johtua ultrakevytlentämisen helposta aloittamisesta ja kevyestä koulutuksesta. Ultrakevyet lentokoneet ovat myös keveytensä vuoksi herkkiä tuulenpuuskille, varsinkin nousun ja laskun aikana.

3. LENTOKONEEN ESITTELY

Eurostar EV-97 on ultrakevyeksi luokiteltu rinnakkain istuttava yksimoottorinen metallirakenteinen alatasokone. Se on varustettu kiinteällä laskutelineellä ja ohjattavalla nokkapyörällä.

Koneen runko on puolikuorirakenteinen (semi-monocoque) joka muodostuu jäykisteistä sekä duralumiinipintalevystä. Sivuvakaaja on osa runkoa. Runko on koottu niittaamalla.

Kuva 2 TAMKin Ilmailukerhon Eurostar EV-97 Pirkkalassa

Suorakaiteen muotoinen siipi on yksisalkoinen (monospar) rakenne jossa on apusalko (auxiliary spar) ohjainsiivekkeiden ja laskusiivekkeiden kiinnityspisteitä varten. Siiven pintamateriaali on duralumiinilevy, ja se on kaikilta osin koottu niittaamalla. Siipien kärkiin on niitattu lasikuituiset kärkikappaleet. Siipi voidaan varustaa taittomekanismilla helpottamaan varastointia (taittomekanismia ei TAMKin koneeseen rakennettu).

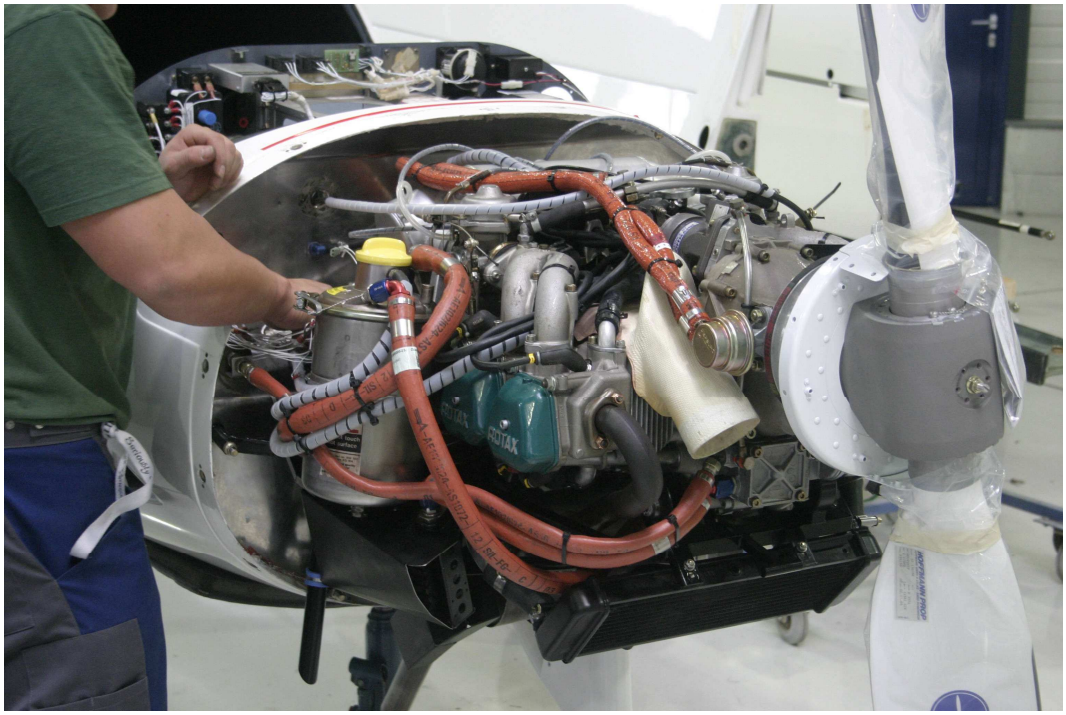
Kummassakin siivessä on suorakaiteenmuotoinen ohjaussiiveke, joka muodostuu kaarista ja muotoon taivutetusta duralumiinilevystä. Siiveke kiinnittyy siipeen saranoilla.

Laskusiivekkeet kattavat 2/3 kummastakin siivestä. Laskusiivekkeet ovat suorakaiteen muotoiset, ja niiden rakenne on samankaltainen kuin ohjaussiivekkeiden.

Takasiipi (HTU, Horizontal Tail Unit, kuten kokoamisohje sanoo) sisältää korkeusvakaajan ja korkeusperäsimen. Vakaaja on puolikuorirakenteinen, sisältäen salon, kaaret ja duralumiinipintalevyn. Korkeusperäsimen rakenne on kuten siivekkeissä ja se on kiinnitetty saranoilla vakaajaan.

Sivuperäsimen rakenne on kuten siivekkeissä. Se kiinnittyy sivuvakaajaan (eli runkoon) kahdella peräsimen etureunassa olevalla tapilla ja on varmistettu kahdella ruuvilla peräsimen takareunasta.

Koneen moottorina voi olla Rotax 912UL (80 hv) tai 912ULS (100 hv) nelisylinterinen nestejäähdytteinen bokserityyppinen nelitahtimoottori. Moottori on varustettu kuivasumppuvoitelulla. Tehdas lupaa myös asentaa muita moottoreita niin pyydettäessä. TAMKin rakentamaan koneeseen valittiin 100 hv Rotax-moottori.



Kuva 3 Rotax 912 –moottori asennettuna Eurostar-koneen nokalle Evektorin tehtaalla.

Eurostar EV-97 on yksi tämän hetken suosituimmista ultrakevyistä lentokoneista, yli 400 konetta on toimitettu yli 30 eri maahan (vuoden 2006 tieto).

4. VIERAILU EVEKTORIN TEHTAALLA

Tsekinmaa on tunnettu vahvasta koneenrakennusperinteestään, siellä sijaitsevat mm. Skodan tehtaat. Ilmailuakin alueella on harrastettu aivan alkuajoista lähtien, jo ensimmäisen maailmansodan aikoihin muun muassa Letov korjasi sotasaaliiksi saatuja koneita Itävalta-Unkarin lentojoukkojen tarpeisiin. 20- ja 30-luvuilla Tsekkoslovakiassa oli jo muutamia lentokonetehtaita, Tsekkien omaa suunnittelua oli mm. Avia B-534 –kaksitasoinen hävittäjä. Kylmän sodan aikana silloinen Tsekkoslovakia sai rakentaa harjoitushävittäjiä koko Varsovan liitolle, koneena oli ensin Aero [Vodochody] L-29 ja sittemmin L-39, uusin versio on 1996 ensilentonsa saanut L-59 Super Albatros.

Kuva 4 Evektorin tehdasrakennus Kunovicessä

Evektor-Aerotechnik on perustettu vuonna 1999. Perustamisen pohjana oli pieni paikallinen 1970 perustettu lentokonevalmistaja Aerotechnik, ja suuren osan työvoimasta muodostavat entisen sotilaskonetehtaan Let Kunovicen työntekijät. Vuonna 2000 Evektor-Aerotechnik valmisti ensimmäisenä varsinaisena projektinaan prototyypin yleisilmailukoneesta Wolfsberg Raven 257.

Kuva 5 Vierailuryhmä Diamond Aircraftin edessä Itävallassa

Evektor-Aerotechnikin tehdas sijaitsee Tsekin tasavallassa Kunovicen kylässä. Vierailimme siellä 1.12.2004. Tehtaalla sai vierailumme aikana käyskennellä ja katsella kohtuullisen vapaasti ympärilleen. Tulevaa projektia ajatellen se oli todella hyödyllistä, tehtaalla pääsi näkemään perinteisen, niittaamalla kootun, lentokoneen rakentamista alusta alkaen. Koneen rakentamisen tarkkailu oli hyödyllistä siinäkin mielessä, että saatoimme samalla miettiä sitä, mitkä osakokonaisuudet on järkevää tilata koottuina. Tässä konetta rakentamaan pääsevällä osapuolella olikin mukavasti sananvaltaa, pyrimme siihen että hankalasti valmistettavia jigejä ei tarvitsisi ruveta tekemään.

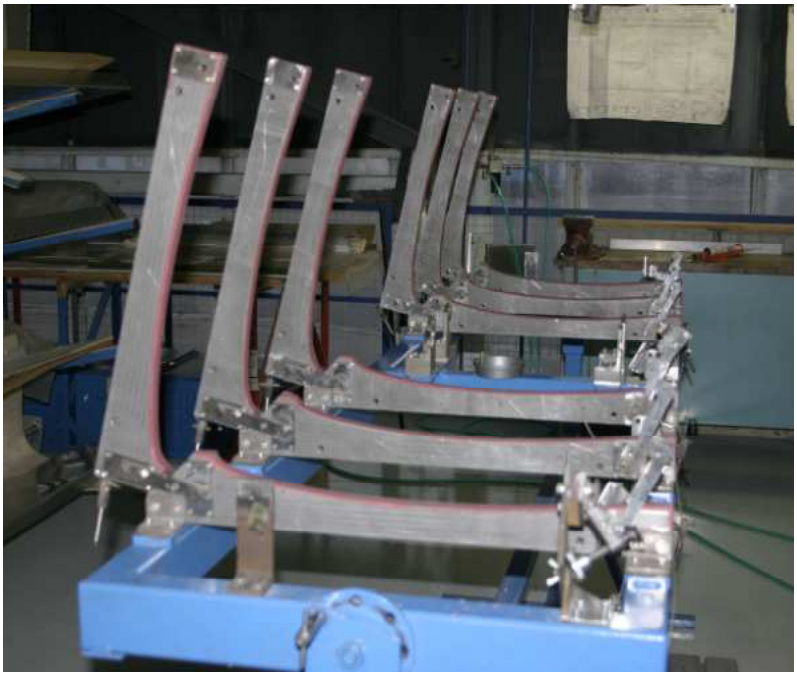
Tehtaalla oli myös nähtävänä useita valmiita koneita. Näistä saimme hyvää tietoa siitä että miltä kyseinen kone valmiina näyttää, ja pystyimme myös vertailemaan sitä, miten eri varusteiden asennus on toteutettu ja miten ne vaikuttavat koneen rakenteeseen ja muiden varusteiden sijoitteluun.

Tehtaan antia oli myös käyttöön tulevien työtapojen näkeminen. Vaikka kommunikointi ei varsinaisten asentajien kanssa onnistunutkaan kielimuurin

vuoksi, niin monenlaista hyödyllistä informaatiota tarttui mukaan jopa oppaan eli tulkin välityksellä kommunikoidessa.

5. LENTOKONEEN RAKENNUSSARJA

Koneen rakennussarjaa tilattaessa pääasiallisena ajatuksena oli, että tilaamme koneen mahdollisimman alkutekijöissään, jotta opiskelijoilla olisi mahdollisimman paljon tehtävää. Evektorilla käydyissä keskusteluissa päädyimme kuitenkin tilaamaan lentokoneen rungon kokoon niitattuna ”ammeena” ja siiven pääsalkoa lukuun ottamatta osina. Näin päätettiin, koska jigien rakentaminen koneen rungon niittaamista varten olisi ollut suuritöistä. Myös korkeusvakaaja tilattiin kokonaisena.



Kuva 6 Takasiiven (HTU) jigi Evektorin tehtaalla

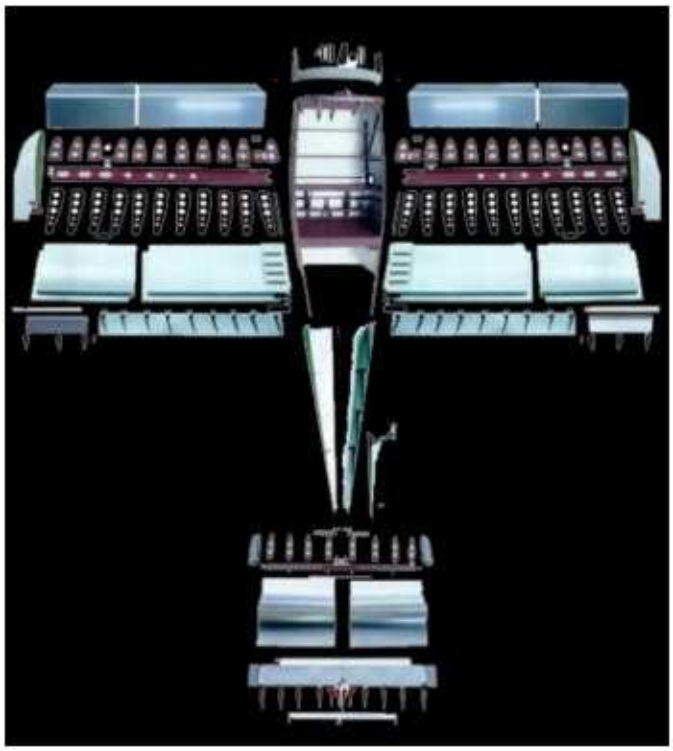
Edellä mainittujen jigien rakentaminen (HTU ja runko) olisi edellyttänyt erityisosaamista sekä alihankintatyötä ja täten korottanut projektin kustannuksia ja

pidentänyt koneen rakennusaikaa mielestämme enemmän kuin sen opetuksellinen hyöty olisi ollut.

Tilaamamme rakennussarja sisälsi seuraavat osat ja osakokonaisuudet:

- koottu runko sivuvakaajalla
- niitatut siiven pääsalot
- kaikki siipiin tarvittavat osat
- pyrstöosa, siivekkeet ja laskusiivekkeet tarvittavine osineen
- laskuteline ja sen osat
- laskutelineen vanteet ja renkaat
- nestejarrut
- tuliseinä
- esivalmistettu kuomu, kehyksineen ja lukituksineen
- ohjaamo
- 65 litran polttoainetankki
- kaksoisohjaus-, jarru- ja laskusiivekevivustot
- pitotputki
- istuinvyöt

Moottori kiinnityspukkeineen ja pakokaasujärjestelmineen hankittiin toisaalta. Avioniikka hankittiin sekin eri toimittajilta. Ohjaamon verhoilu päätettiin teettää koulun omilla verhoilijoilla.



Kuva 7 Rakennussarjan räjäytyskuva /5/

6. LENTOKONEEN RAKENTAMINEN

Pitkällisen odottelun jälkeen lentokoneen rakennussarja saapui 4.2.2005. Alkuaan ensimmäisiä osia oli lupailtu ja odotettu jo kuukautta aiemmin, koska alun alkaen toimituksen piti tapahtua kahdessa osassa. Loppujen lopuksi rakennussarja tuli kokonaisuudessaan kerralla yhdellä toimituksella. Kahden toimituksen ideana oli ollut se, että me opiskelijat olisimme aikaisemmin päässeet työhön eli koneenrakentamiseen kiinni. Loppujen viimeksi tuolla kuukauden viivästyksellä ei juurikaan ollut merkitystä koneen valmistumisajankohdalle, mutta heti alkuun aiheutti hieman turhaa jännittämistä projektin edistymisen ja aikataulujen tekemisen suhteen.

Kuva 8 Rakennussarja saapuu vihdoinkin 4.2.2005

Koneen rakentamisen aloitimme hieman eri järjestyksessä kuin rakennusohjekirjassa oli neuvottu. Mitään erityistä syytä tähän ei ollut, päätimme vain käyttää meille paremmin sopivaa järjestystä niiltä osin kuin se oli mahdollista. Tämä luonnollisesti koski sellaisia osakokonaisuuksia, joitten keskinäisellä valmistumisjärjestyksellä ei ollut merkitystä kokonaisuuden kannalta.

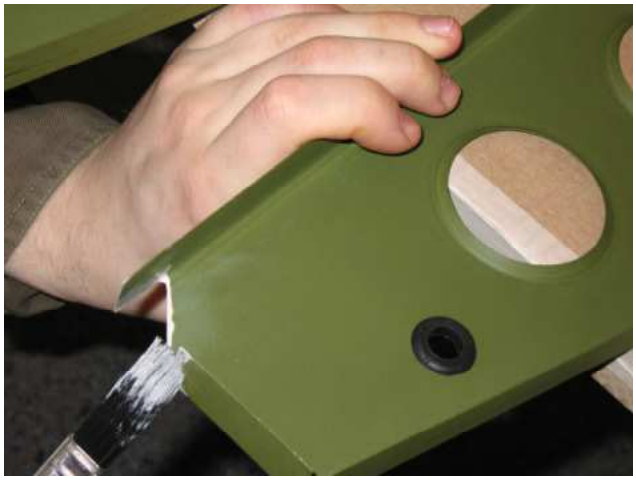
Osaltaan kokoonpanojärjestystä sanelivat käytössämme olleet tilat, projektin alkuvaiheessa pöytätilaa oli käytössämme hieman rajoitetusti. Siivet piti rakentaa pitkän, suoran pöytätason päällä. Ne jouduimme rakentamaan erikseen tätä tarkoitusta varten.

6.1 Siivet

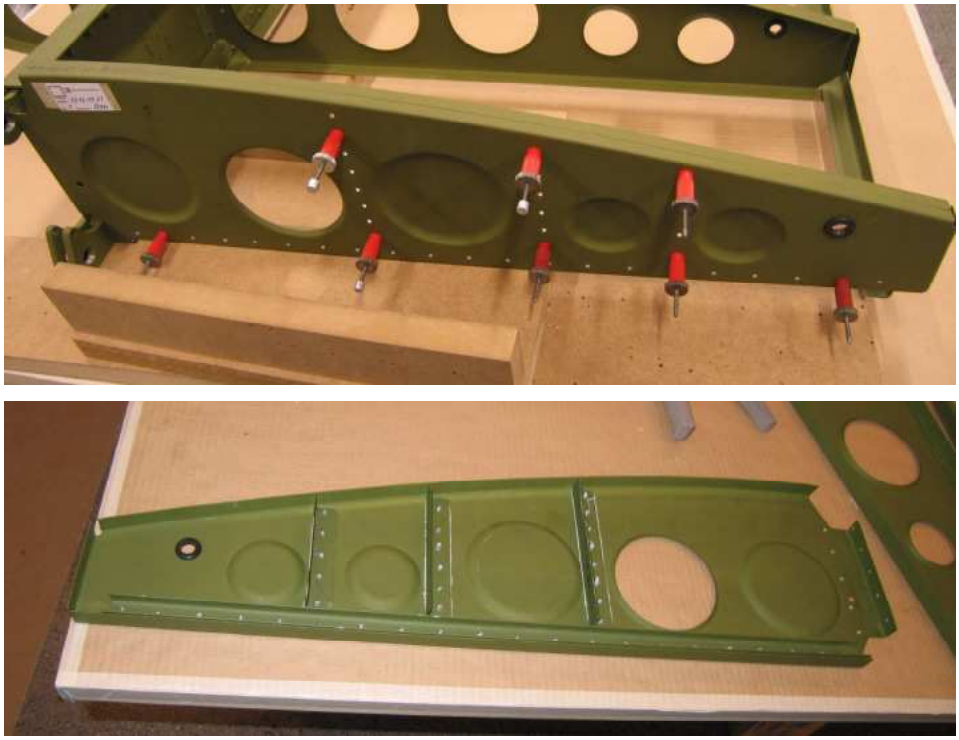
Ensimmäisenä työvaiheena päätimme koota siiven sisäisen rakenteen. Tähän vaiheeseen kuului siipikaarien niittaaminen kiinni siiven pääsalkoon ja siivekkeiden ohjausmekanismin rakentaminen. Siipikaaret koostuivat johtoreunan ja jättöreunan puoleisista puolikkaista, jotka niitattiin pääsalkoon.

6.1.1 Siipikaarien valmistelu

Tämän vaiheen ensimmäinen työ oli siipikaarien yksi (1) ja kaksi (2) vahvistus ja valmistelu. Nämä kaksi siipikaarta tuli vahvistaa siitä syystä, että juuri siltä kohdin siipeä kuljetaan koneen ohjaamoon. Vasemman siiven siipikaariin 1 - 8 porattiin lisäksi kaksi kappaletta Ø11mm reikiä pitot-staattiselle järjestelmälle.

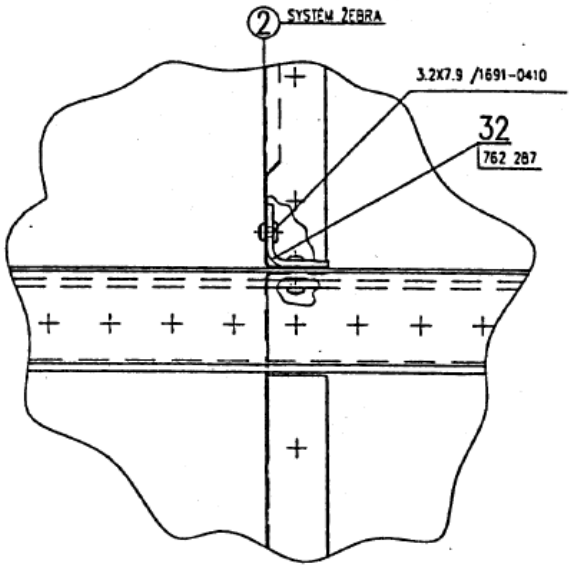


Kuva 9 Siipikaareen 2 tehtiin 24 x 24 mm leikkaus. Tämä oli ensimmäinen suoritettu työ. Näkyvissä myös ”technological hole” ja siihen asennettu kuminen läpivienti.



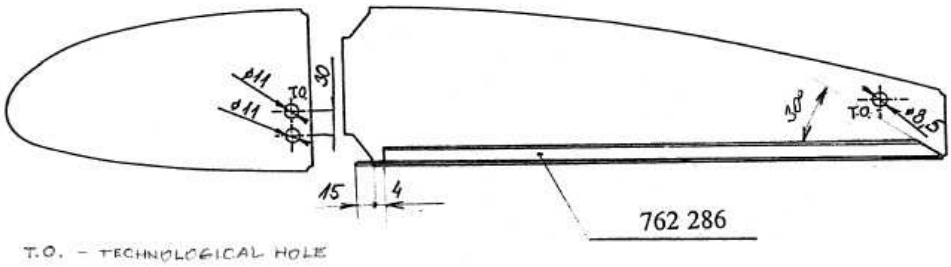
Kuva 10 Siipikaarien vahvistaminen

Siipikaarien vahvistaminen aloitettiin vahvikkeesta osanumero 762 287 (alumiinikulmaprofiili). Tähän vahvikkeeseen oli jo tehtaan toimesta porattu Ø3.3 mm reiät, joita ohjauksena käyttäen porattiin niitinreiät (Ø3.3 mm) kaareen numero 2. Jäysteet poistettiin, levitettiin Emfimastic-liimaa vastaaville pinnoille ja niitattiin vahvike 762 287 paikoilleen. Sitten, käyttäen ohjauksena tällä kertaa siipikaaren taitteessa olevia reikiä, porattiin Ø3.3 mm reiät vahvikkeeseen. Näistä rei'istä kaaren puolikas kiinnitettiin myöhemmin siiven pääsalkoon.



Kuva 11 Vahvikkeen 768 287 asennus /1/

Kaaren 1 pituusjäykisteeseen osanumero 762 286 sahattiin 30° viiste ohjekirjan kuvan ja ohjeen mukaisesti, sitten jäykiste porattiin ja niitattiin Ø3.2x7.9 mm niiteillä kiinni kaareen 1, väliin laitettiin luonnollisesti Emfimastic-liimaa. Tämän jäykisteen kiinni niittaamisen jälkeen niitattiin vastaavasti kiinni jäykisteet 45, 47 ja 48.

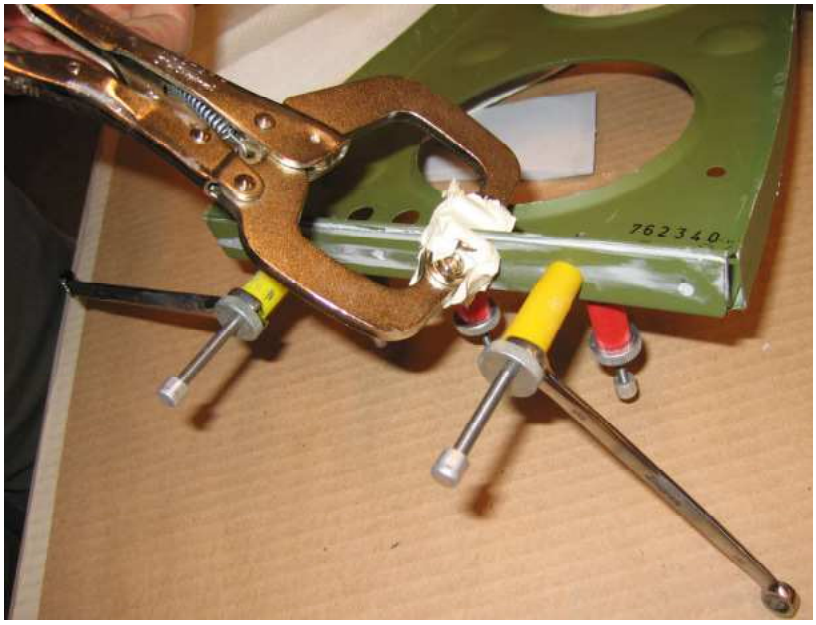


Kuva 12 Kaaren 1 pituusjäykiste ja ”Technological hole” /1/

Jäykiste 42/43 olikin sitten vähän suuritöisempi. Koska kyseessä oleva jäykiste oli samanlainen kulmaprofiili kuin kaikki muutkin, niin siihen piti leikata kolo kaaressa olevan kevennysreiän kohdalle. Tämä piti tehdä siitä syystä, että kyseessä olevasta kevennysreiästä kulki siivekkeen ohjausvivusto. Sinänsä ensituntumalta yksinkertaiselta vaikuttavaa operaatiota hankaloitti se, että kyseessä olevan

jäykisteen paikoittaminen oli vaikeahkoa. Huomioon piti ottaa muun muassa tarvittavat niitinreikien reunaetäisyydet ja se, että siipikaaren kevennysreiässä oleva jäykistepokkaus säilyi ehjänä.

Näitten lisäksi kaikkiin siipikaarien jättöreunan puoleisiin puolikkaisiin valmiiksi porattuun Ø8.5 mm ”Technological hole:ihin” laitettiin läpivientikumi lentovalojen sähköjohtoja varten. Lopuksi merkittiin kaikkiin siipikaariin niitten keskilinjat.



Kuva 13 Kaaren 1 johtoreunan puoleinen puolikas ennen osan 768 287 niittausta

6.1.2 Siipikaarien niittaus pääsalkoon

Ensimmäiseksi merkittiin ja mitattiin molempien siipikaaren puolikkaiden paikat siiven pääsalkoon rakennusohjeen mukaan. Apuna käytettiin yksinkertaista puista jigiä ja suorakulmaa. Siipikaarien puolikkaiden kiinnittäminen pääsalkoon aloitettiin johtoreunan puolelta.

Suorakulmaa ja jigiä apuna käyttäen aseteltiin johtoreunan puoleiset kaaren puolikkaat yksi kerrallaan paikoilleen. Käyttäen kohdistimena kaaressa olevia valmiiksi porattuja reikiä porattiin niittirivin päissä olevat reiät (eli kaaren taitteen ylimmäinen ja alimmainen reikä) siiven pääsalkoon pitkällä Ø2.5 mm poralla. Sitten kiinnitettiin kaaren puolikas satiaisilla pääsalkoon näistä kahdesta poratusta reiästä ja porattiin loput reiät. Kaaren puolikkaat irrotettiin ja numeroitiin sitä mukaa kuin reiät oli porattu.

Kuva 14 Siipikaarien kiinnitysreikien porausta

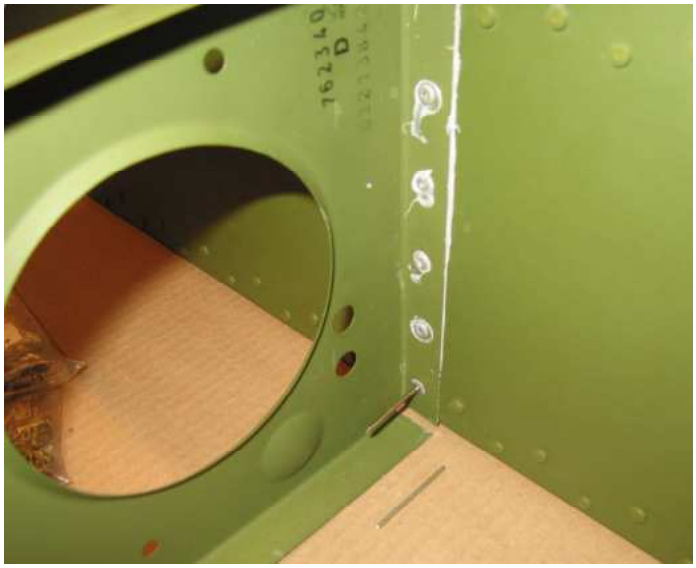
Siipikaarien jättöreunan puoleisten puolikkaiden niitinreiät porattiin käyttämällä äsken pääsalkoon porattuja reikiä ohjauksena. Kaarien paikoilleen asettelun apuna käytettiin jälleen suorakulmaa. Työvaiheessa tarvittiin kahta henkilöä, toinen porasi reiän ja toinen painoi siipikaaren puolikasta siipisalkoa vasten sopivalla puupalikalla kuten kokoamisohjeessa neuvottiin. Porauksen jälkeen kaaret numeroitiin ja irrotettiin.

Kun kaikki Ø2.5 mm reiät oli porattu, porattiin lopulliset Ø3.3 mm reiät kaariin ja pääsalkoon niittausta varten.

Siipikaarien niittaus pääsalkoon aloitettiin kaaresta 1. Emfimastic-liimaa levitettiin toisiinsa vastaaville kosketuspinnoille. Kaaret kiinnitettiin satiaisilla pääsalkoon ja niitattiin paikoilleen. Kaareen 2 porattiin vielä Ø4.1 mm reiät siinä käytettäville hieman järeämmille (Ø4 mm) niiteille. Kaarien niittaamisessa pääsalkoon käytettiin normaaleja Ø3.2 x 7.9 mm niittejä, paitsi kaaressa 2, joka kiinnitettiin Ø4 x 9.5 mm ja Ø4 x 16.7 mm niiteillä.

Kuva 15 Esikoottu siiven rakenne. Kuvan etualalla aiemmin mainittu jigi siipikaarien paikkojen merkintään.

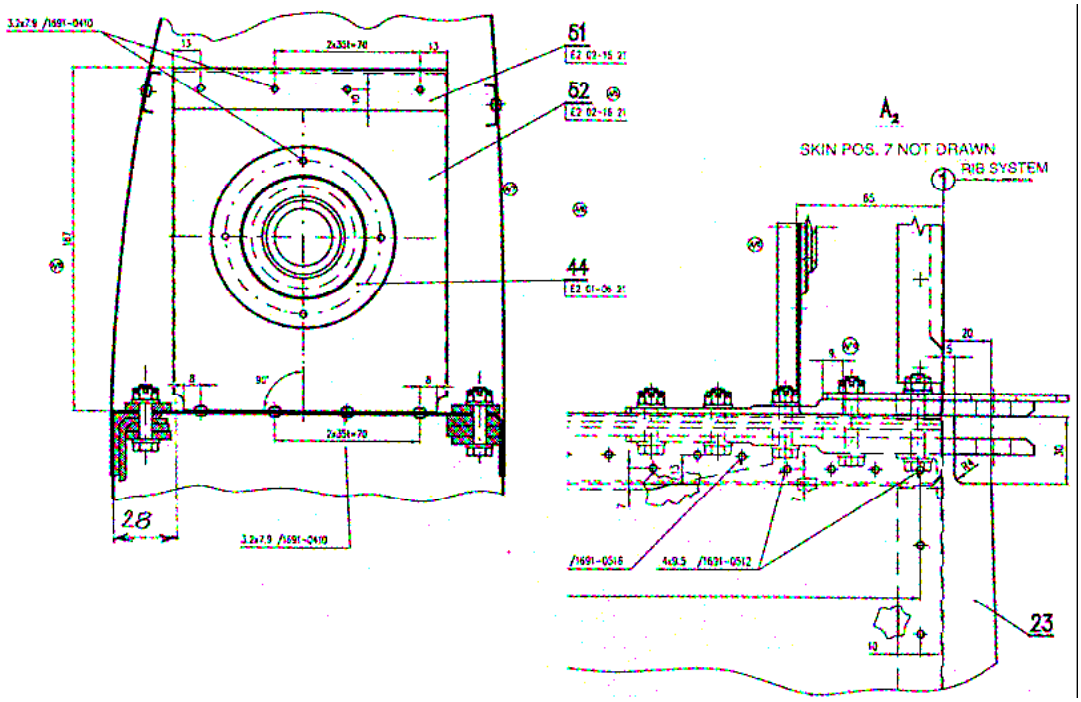
Kuva 16 Siipikaaren niittaus



Kuva 17 Niitattu liitos

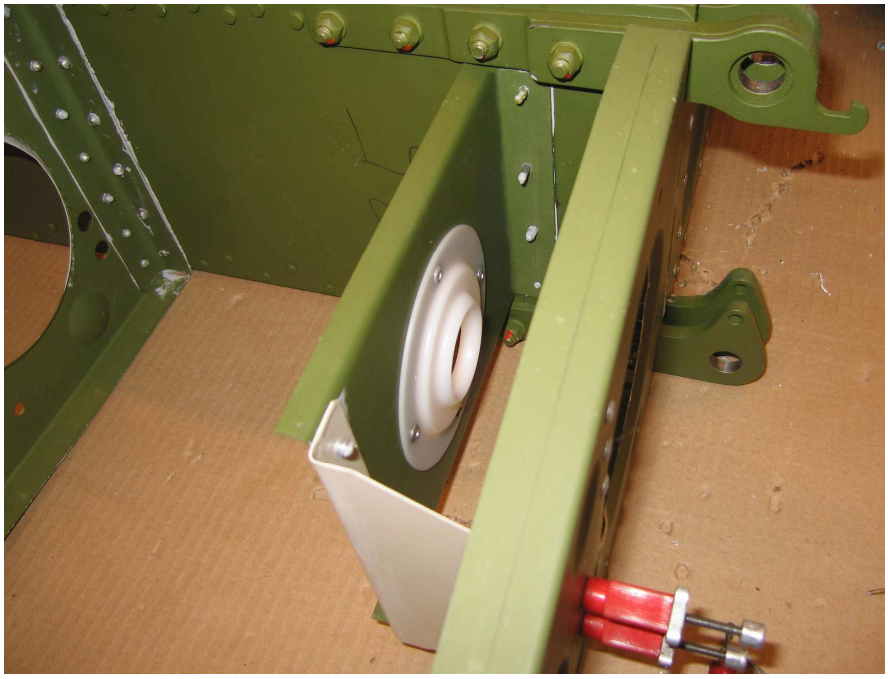
6.1.3 Siivekkeen ohjausvivuston asentaminen

Muovinen ohjausrengas (E2 01-0621, pos 44) niitattiin kiinni kannakkeeseen E2 01-1621 Ø3.2 x 7.9 mm niiteillä. Kannake aseteltiin 65 mm etäisyydelle siipikaari 1:stä, ja kannakkeeseen esiporattuja Ø2.5 mm reikiä ohjauksena käyttäen porattiin Ø2.5 mm reiät pääsalkoon ja kiinnitettiin kannake satiaisilla. Tämän jälkeen aseteltiin kannakkeen tuki (E2 01-1521, pos 51) paikoilleen ja porattiin tuen kiinnitysreiät siipikaareen sekä kannakkeen puoleiset reiät tukeen. Nämä kiinnitettiin ja sovitettiin satiaisien kanssa. Satiaiset irrotettiin yksi kerrallaan ja porattiin reiät Ø3.3 mm kokoon.



Kuva 18 Ohjausvivuston ohjausrenkaan asennus /1/

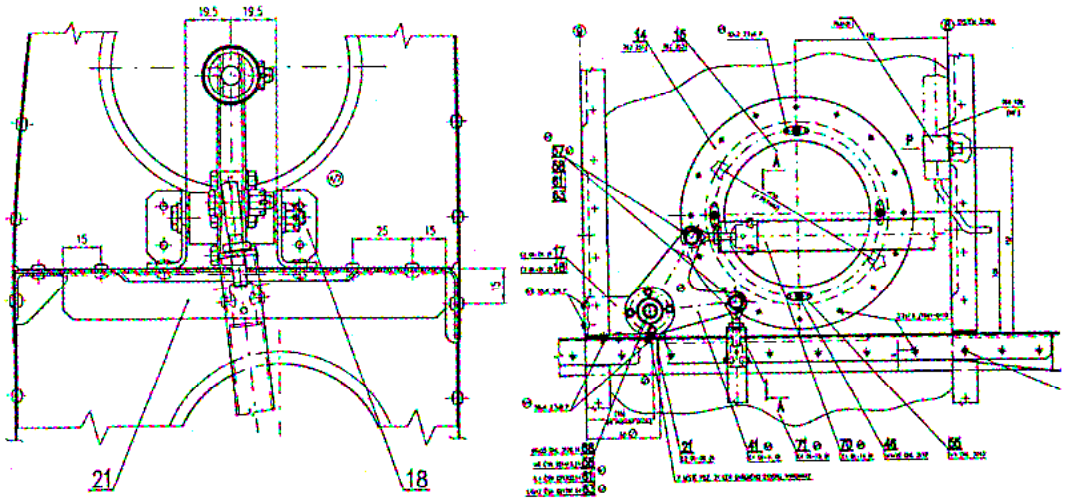
Emfimastic-liimaa levitettiin kosketuspinnoille, osat puristettiin yhteen ja tuki ja kannake niitattiin kiinni Ø3.2 x 7.9 mm niiteillä pääsalkoon ja kaareen 1.



Kuva 19 Ohjausvivuston ohjausrengas

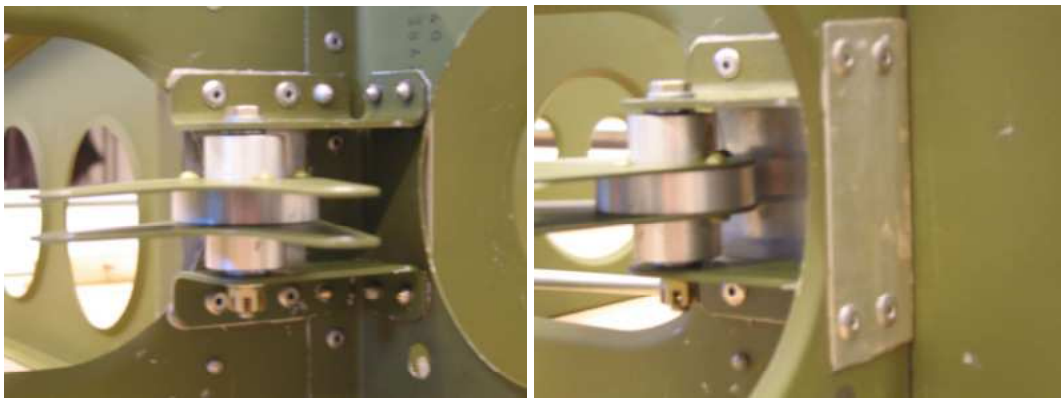
Ohjausvivuston sarana asennettiin siipikaaren numero 9 kohdalle. Sarana-asetelma esikoottiin ja merkittiin sen kiinnitysreikien paikat pääsalkoon ja kaareen 9. Kiinnitystä varten porattiin jälleen ensin Ø2.5 mm esireiät, kiinnitettiin sarana-asetelma satiaisilla paikoilleen ja porattiin siipisalkoon Ø4.1 mm niitinreiät sarana-asetelman lopullista kiinnitystä varten.

Ennen sarana-asetelman kiinnitystä piti tasoittaa siiven kaaren kevennysreiän ”pokkaus” vasaralla ja aseteltiin vahvike (E2 01-0821, pos 21) paikoilleen. Tämän olimme tehneet jo kaarta 1 valmisteltaessa.



Kuva 20 Siivekkeen ohjausvivuston saranan asennuspiirustus /1/

Emfimastic-liimaa levitettiin kosketuspinnoille, osat puristettiin yhteen ja sarana-asetelma ja vahvike niitattiin kiinni Ø4 x 9.7 mm niiteillä pääsalkoon ja Ø3.2 x 7.9 mm niiteillä kaareen 9.

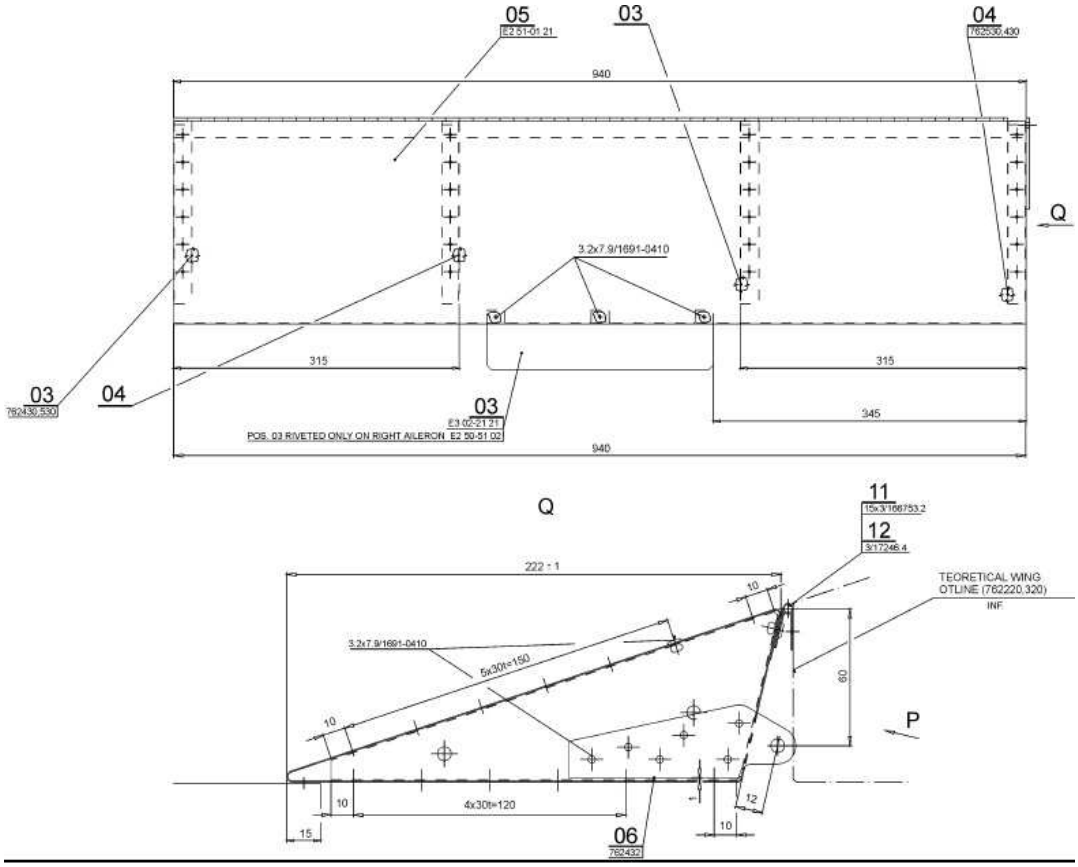


Kuva 21 Ohjausvivuston sarana. Kirkas alumiinivahvike siipikaareen valmistettiin itse, se ei kuulunut rakennussarjaan.

6.2 Ohjaussiivekkeet

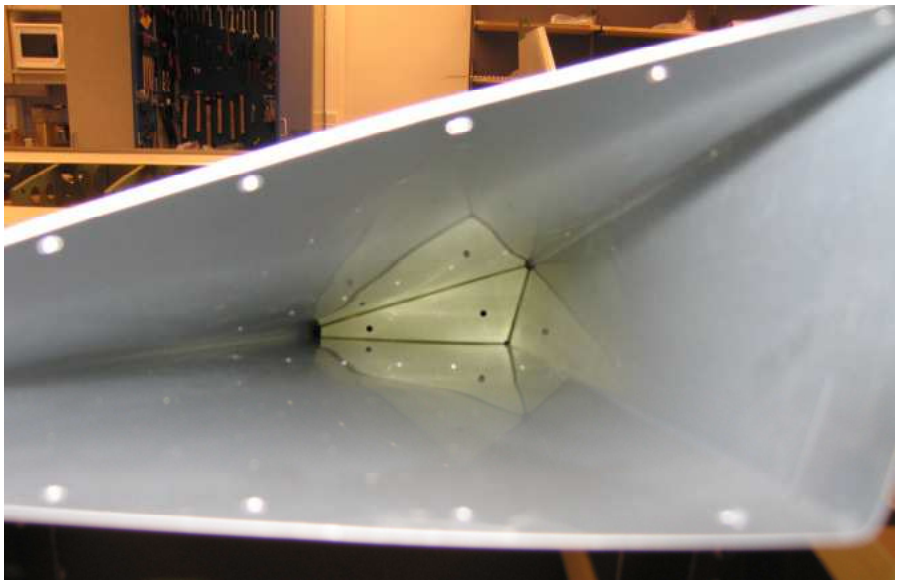
6.2.1 Siivekkeen kaarien niittaus

Ensiksi merkittiin kaarien 3 ja 4 keskikohdat kaariin ja pintapeltiin merkittiin reikien paikat. Esireiät satiaisia varten porattiin Ø2.5 mm poralla. Rakennusohjekirjan mukaan olisi Ø2.5 mm reikien poraamisen jälkeen pitänyt esiasennus purkaa ja suorittaa porattujen reikien siistiminen eli porausjäysteen poisto. Tätä asiaa ammattilaisilta tiedustellessamme saimme kuulla, että tuohon ei varsinaisesti ole tarvetta, riittää kun suorittaa jäysteenpoiston lopulliselle (Ø3.3 mm) reiälle.



Kuva 22 Siivekkeen rakennusohje /1/

Keskimmäiset kaaret sovitettiin muotoon taivutetun pintapellin sisälle siten, että kaaren keskilinjalle piirretty viiva oli pintapellissä olevien reikien keskellä, ja porattiin kaariinkin Ø2.5 mm esireiät. Tämä oli hieman hankala työvaihe, kahdenkaan ihmisen kädet eivät tahtoneet riittää siihen, että kaari olisi ollut meitä tyydyttävästi paikallaan porausta varten, ja käytettävissä olevat puristimet eivät ylettyneet keskimmäisiin kaariin. Pieniä ongelmia havaitsimme myös kaarien pitämisessä paikallaan ensimmäistä reikää porattaessa. Pääasiallinen murheen aihe tässä oli kaaren luistaminen jättöreunan suuntaan.



Kuva 23 Ohjaussiivekkeen sisäpuoli

Sitä mukaa kuin reikiä porattiin, lukittiin levyt satiaisilla toisiinsa. Samalla tavalla kiinnitettiin siivekkeen päätyjen kaaret. Jättöreunan lähelle sijoitettuja reikiä poratessa tuli noudattaa erityistä huolellisuutta, ettei pintapeltiin tulisi sisäpuolelle naarmuja, jotka aiheuttaisivat myöhemmin rakenteeseen syöpymiä. (Naarmut rikkovat alumiinin pinnan korroosiolta suojaavan oksidikerroksen.)

Sitten kun tässä vaiheessa tarvittavat apureiät oli porattu (siivekkeen saranan ja etureunan reikiä ei vielä porattu), porattiin lopulliset reiät (Ø3.3 mm)siivekkeen alapuolelle, yksi kerrallaan satiaisia sitä mukaa suurempiin vaihtaen. Lopullisten

reikien poraamisen jälkeen satiaisilla esikoottu siiveke purettiin jonka jälkeen rei'ille suoritettiin jäysteenpoisto.

Siivekkeen lopullinen kokoaminen alkoi Emfimastic-liiman levittämisellä kaariin. Kaaret aseteltiin paikoilleen pintalevyn sisälle ja kiinnitettiin paikoilleen satiaisilla.

Siivekkeen pintalevyn niittaaminen aloitettiin siivekkeen alapuolesta, joka on suora pinta. Niitteinä käytettiin Ø3.2 x 7.9 mm niittejä. Kun siivekkeen alapuoli oli niitattu, siiveke asetettiin tasaiselle pinnalle oikein päin ja kuormitettiin ohjeen mukaisesti pintalevyä hiekkapusseilla, jotta se asettuisi paikoilleen paremmin. Tämän jälkeen porattiin Ø3.3 mm lopulliset niitinreiät yläpuolen pintalevyyn ja kaariin. Pintalevy niitattiin kaariin samaa työtapaa noudattaen kuin alapuolella tehtiin.

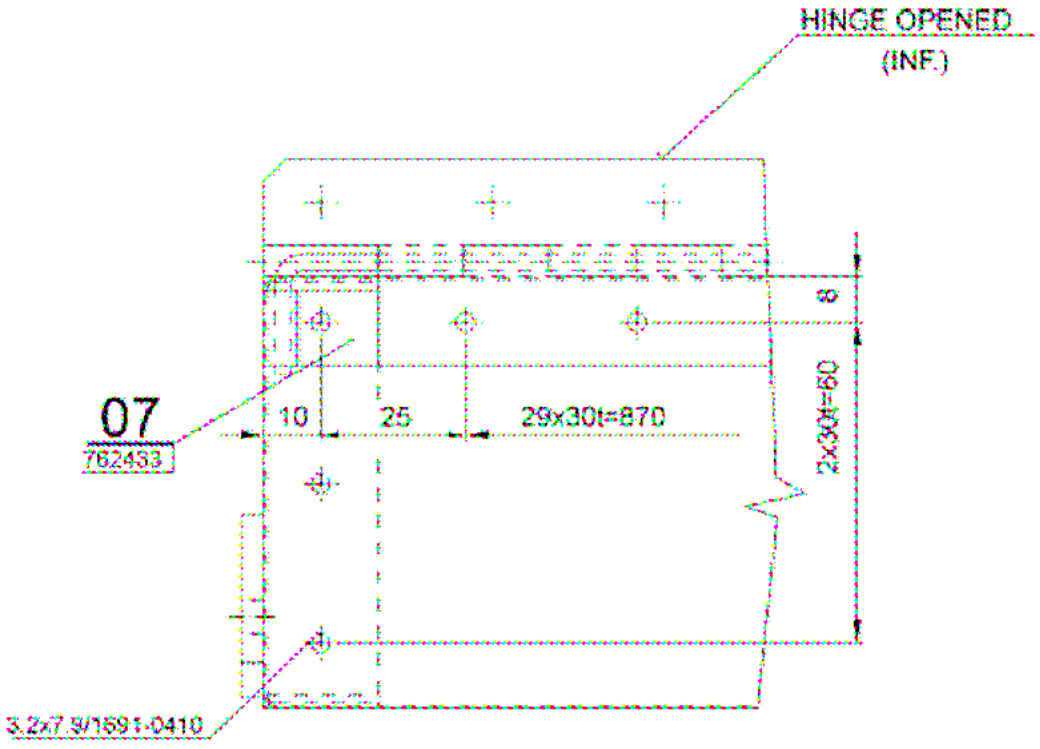
Sitten kun pintalevy oli niitattu ylä- ja alapuolelta ja vielä hiekkapusseilla kuormitettuna, porattiin siivekkeen johtoreunan niitinreiät. Ennen pintalevyn niittausta johtoreunaan pintalevyn sauma tiivistettiin Emfimasticilla. Sitten aseteltiin satiaiset reikiin ja niitattiin johtoreuna kaariin.

Kuva 24 Poratessa syntyneiden naarmujen käsittelyä

6.2.2 Siivekkeen saranan kiinnitys

Siivekkeen sarana on ”huonekalusarana” –tyyppistä tavallista saranaa. Sarana oli rakennussarjassa metritavarana, ja se piti siis ensimmäiseksi leikata sopivaan mittaan.

Saranan kiinnittäminen aloitettiin merkitsemällä oikeaan mittaan katkaistuun saranaan reikien paikat jonka jälkeen porattiin Ø2.5 mm esireiät saranaan. Tämän jälkeen sarananpuolikas aseteltiin vieläkin hiekkapusseilla kuormitetun siivekkeen johtoreunaan ja porattiin Ø2.5 mm reiät siivekkeen kaarien kohdille. Sarana kiinnitettiin niiltä kohdin satiaisilla ja porattiin loput esireiät siivekkeen johtoreunaan. Työtä jatkettiin poraamalla lopulliset Ø3.3 mm reiät.

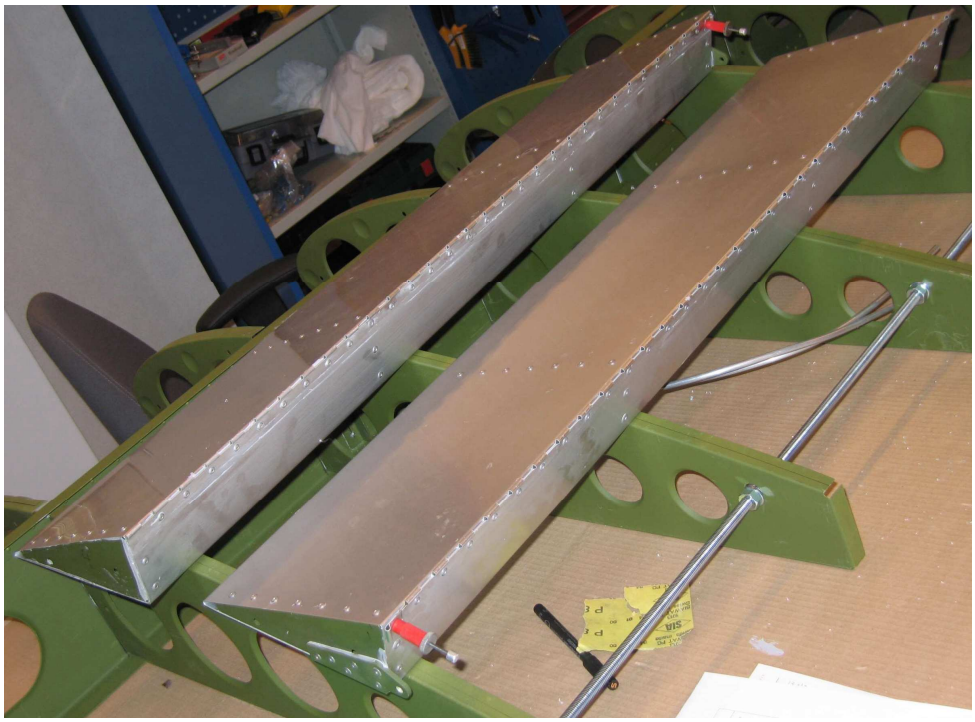


Kuva 25 Siivekkeen saranan asennuspiirustus /1/

Kaikkien saranan kiinnitykseen kuuluvien reikien poraamisen jälkeen sarananpuolikas irrotettiin siivekkeestä, työnnettiin saranatappi paikoilleen ja levitettiin Emfimastic-liimaa saranan siihen puolikkaaseen, joka oli tarkoitus kiinnittää siivekkeeseen. Sitten kiinnitettiin sarana satiaisilla ja niitattiin kiinni.

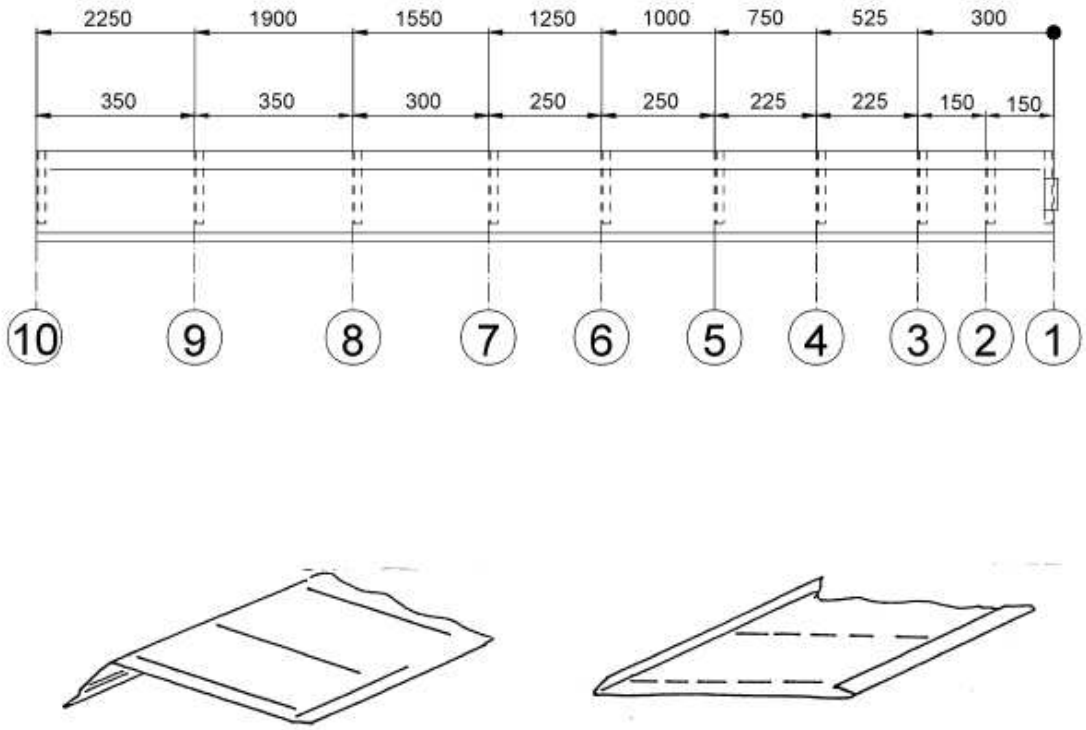
6.2.3 Siivekkeen käyttövivun kiinnitys

Siivekkeen käyttövipu on n.10 mm paksu alumiinikappale. Vipuun porattiin Ø2.5 mm esireiät tehtaan merkintöjen mukaisesti, sen jälkeen vipuun porattuja reikiä ohjauksena käyttäen porattiin vivun kiinnitysreiät kaareen. Siivekkeen kokoamisen viimeisenä vaiheena vipu niitattiin siivekkeen siiven tyven puoleiseen päähän.



Kuva 26 Lähes valmiit siivekkeet

6.3 Laskusiivekkeet



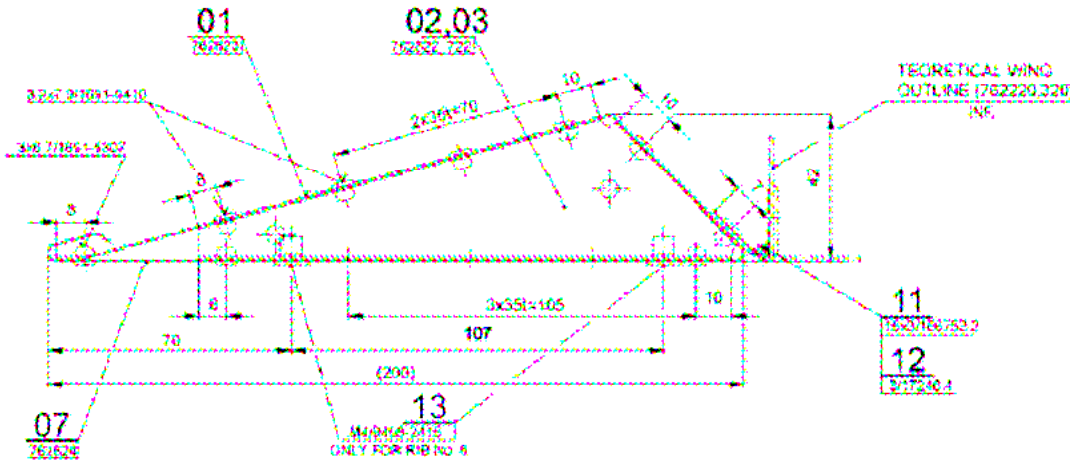
Kuva 27 Laskusiivekkeen ohjepiirustus /1/

6.3.1 Niittauslinjojen teko pintalevyihin ja kaariin

Laskusiivekkeen valmistaminen aloitettiin merkitsemällä niittien paikat siivekkeen pintalevyihin. Tämän jälkeen merkittiin keskilinjat laskusiivekkeen kaariin. Sitten porattiin Ø2.5 mm esireiät laskusiivekkeen pintalevyihin tehtyjen merkintöjen perusteella, paitsi yläpuolen pintalevyyn kaaren 1 reiät, jotka porattiin vasta myöhemmässä vaiheessa.

6.3.2 Kaarien kiinnitys alapintalevyyn

Kaarien paikoittamisessa käytettiin apuna edellisessä työvaiheessa tehtyjä merkintöjä, kaaret paikoitettiin asettamalla ne alapuolen pintalevylle siten, että niihin merkitty keskilinja nähtiin pintalevyyn poratuista esirei'istä.



Kuva 28 Laskusiivekkeen niittausohje /1/

Tästä kohdasta alkoi tarkka työskentely. Ensin porattiin pintalevyyn äsken poratusta reiästä läpi kaaren päähän Ø2.5 mm esireikä, minkä jälkeen kiinnitettiin kaari pintalevyyn satiaisella, aseteltiin kaari oikeaan asentoon ja porattiin samalla tavalla kaaren toiseen päähän reikä. Tällä tavalla saatiin kaari kiinni kunnolla ja pystyttiin poraamaan loput kolme reikää siihen. Sitten aseteltiin jälleen satiaiset reikiin ja jatkettiin poraamalla Ø3.3 mm reiät.

Kuva 29 Laskusiivekkeen niitinreikien porausta

Sama operaatio toistettiin jokaisen kaaren kohdalla, kaaria on kymmenen kappaletta, joten jälleen poraamista riitti. Työvaiheena tämä oli jälleen sellainen että suurempi määrä käsiä olisi ollut avuksi.

Ennen kaaren numero 1 reikien poraamista pohjalevyyn porattiin kaareen 1 laskusiivekkeen ohjurin kiinnitysreiät ja viilattiin kaaressa ollut soikea reikä vastaamaan ohjurissa olevaa reikää. Tässä järjestyksessä toimittiin siksi ettei siivekkeen rakenteen sisälle jäisi niin paljoa metallipurua.

Kun kaikki reiät oli porattu Ø3.3 mm kokoon, kaaret irrotettiin alapellistä, suoritettiin jäysteenpoisto, levitettiin jälleen Emfimastic-liimaa liimattaville pinnoille, aseteltiin kaaret paikoilleen alapellille ja jälleen kiinnitettiin ne ensin satiaisilla ja niitattiin kiinni.

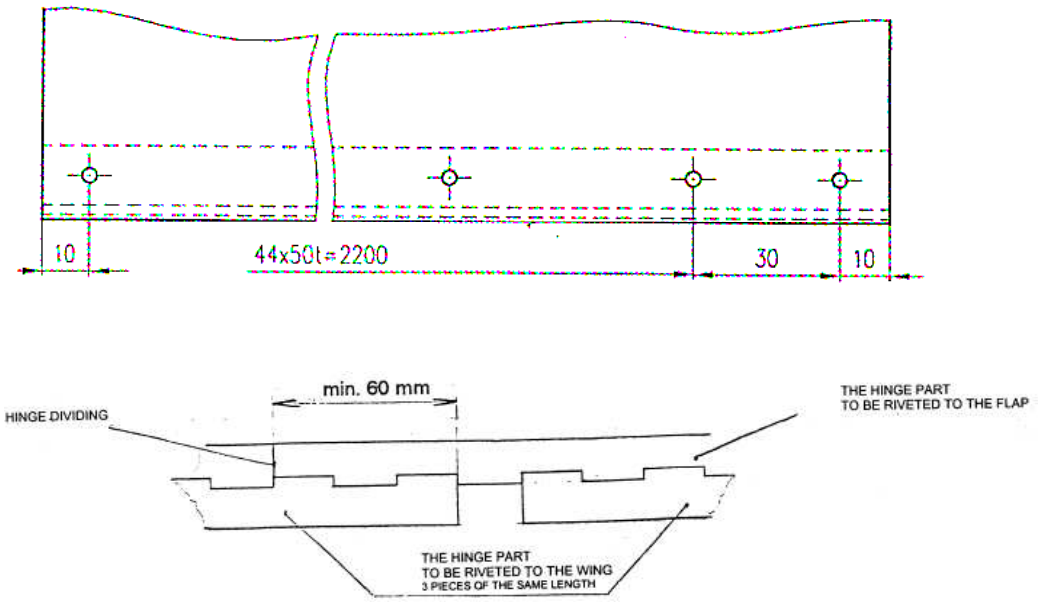
6.3.3 Laskusiivekkeen yläpintalevyn niittaus

Yläpintalevyn niittaus aloitettiin asettamalla levy siivekkeen kaarien päälle siten että kaariin merkityt keskilinjat olivat nähtävissä levyyn aiemmin poratuista rei'istä. Levyyn porattuja reikiä ohjauksena käyttäen, porattiin Ø2.5 mm reiät siipikaariin ja kiinnitettiin pintalevy satiaisilla sitä mukaa kun edettiin. Samalla myös porattiin ja kiinnitettiin satiaisilla siivekkeen jättöreuna. Siiven tyven puoleiseen päähän laskusiivekettä (kaari 1) porattiin vielä reiät kulmajäykisteelle (ohjeissa pos.5, s 6-5).

Jälleen purettiin, puhdistettiin ja suoritettiin jäysteenpoisto. Kokoaminen aloitettiin jälleen levittämällä Emfimastic-liimaa toisiinsa vastaaville pinnoille (Tässä työvaiheessa käytimme ohjekirjan suosittamaa työjärjestystä Patrian asiantuntijoiden neuvoman sijaan) ja esikiinnitettiin yläpintalevy Ø2.5 mm satiaisilla. Laskusiivekkeen suora pohja asetettiin tasaiselle pinnalle (eli työpöydälle) ja kuormitettiin yläpintalevy vanerilevyn päälle asetelluilla hiekkapusseilla. Poistettiin satiaiset yksi kerrallaan, porattiin ohjeen mukaisesti reiät sitä mukaa Ø3.3 mm kokoon ja saman tien niitattiin Ø3.2 x 7.9 mm niiteillä levy kiinni kaariin. Viimeiseksi niitattiin samalla työjärjestyksellä siivekkeen jättöreuna Ø3 x 6.7 mm niiteillä.

6.3.4 Laskusiivekkeen saranan niittaus

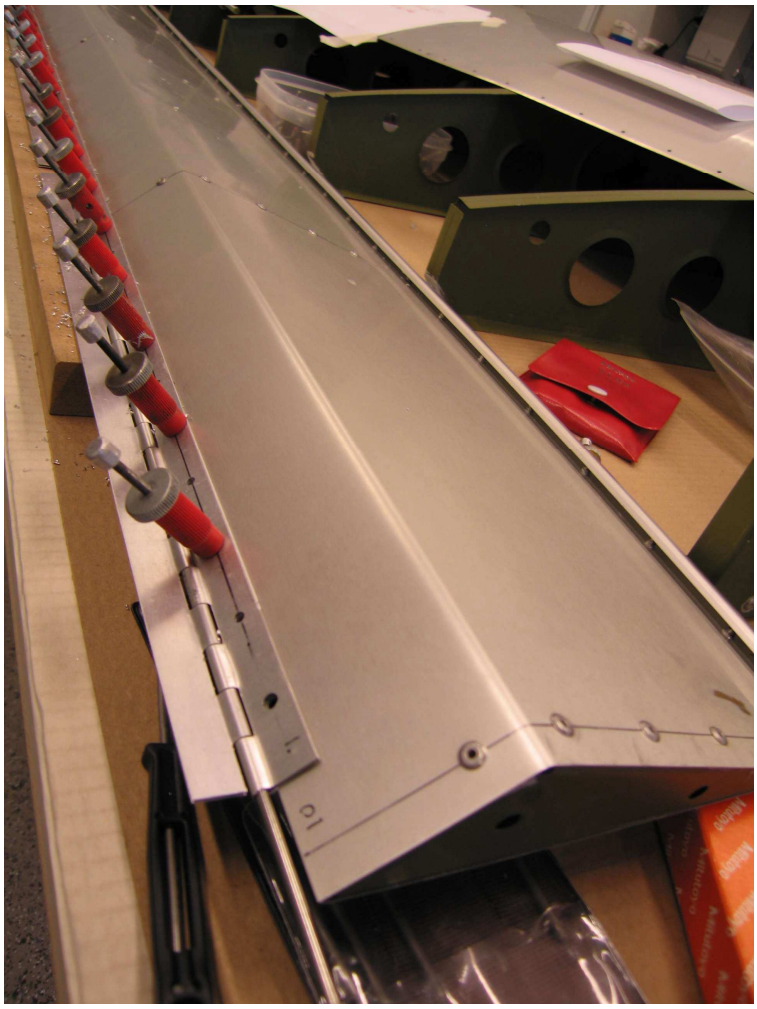
Rakennussarjan mukana toimitettu laskusiivekkeen sarana oli lyhyempi kuin siiveke, joten sarana piti katkaista ohjeen mukaan kolmeen osaan. Tuota mietimme pitkään, koska ohjeet saranan kiinnitykseen olivat hieman epämääräiset. Työvaiheessa piti kiinnittää erityistä huomiota siihen, että saranan alareuna on samansuuntainen laskusiivekkeen alapintalevyn kanssa.



Kuva 30 Laskusiivekkeen saranan kiinnitysohje /1/

Ensimmäiseksi merkittiin reikien paikat saranoiden niihin puolikkaisiin jotka tulivat kiinnitettäviksi laskusiivekkeeseen. Sitten saranaan porattiin Ø2.5 mm reiät merkintöjen perusteella.

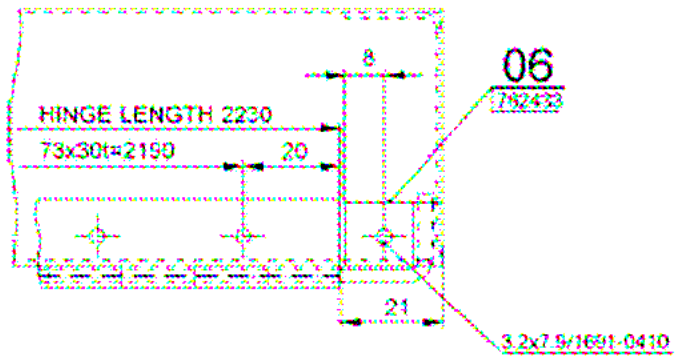
Saranan niittausta varten laskusiiveke jätettiin pöydälle hiekkasäkeillä kuormitettuna edellisen työvaiheen jäljiltä. Samalla tarkastettiin, oliko siiveke kiero. Pienet vääntymät oli ohjekirjan mukaan mahdollista korjata perinteisesti käsin vääntämällä ennen kuin sarana niitattaisiin paikoilleen.



Kuva 31 Laskusiivekkeen saranan esikiinnitys

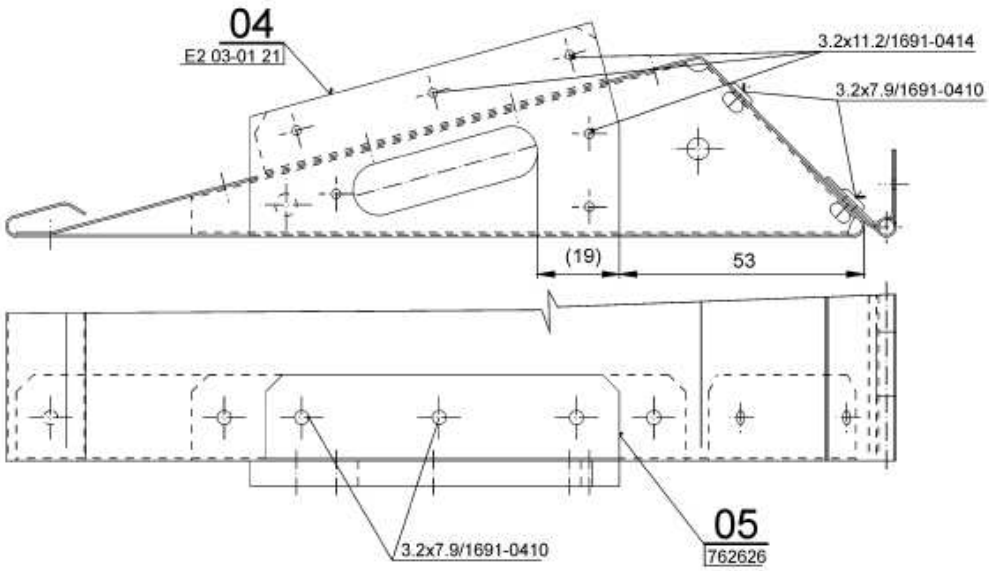
Saranan puolikkaat kiinnitettiin yhteen saranatapilla, jonka jälkeen koottu sarana asetettiin laskusiivekkeen johtoreunaan kuvan 31 mukaisesti. Sitten porattiin siivekkeeseen Ø2.5 mm reiät saranaan aiemmin porattuja reikiä ohjauksena käyttäen, jälleen kiinnittäen saranaa satiaisilla sitä mukaa kun edettiin. Kun tämä oli suoritettu koko matkalta, sarana irrotettiin, suoritettiin jäysteenpoisto ja levitettiin Emfimastic-liimaa saranaan. Sarana kiinnitettiin satiaisilla, ja laskusiivekkeen suoruuden tarkastuksen jälkeen porattiin reiät jälleen yksi kerrallaan Ø3.3 mm kokoon ja samalla niitattiin Ø3.2 x 7.9 mm niiteillä sarana kiinni laskusiivekkeeseen.

Seuraavaksi asennettiin stoppari (pos.6 ohjeessa s. 6-8) saranatappiin ja niitattiin se kiinni laskusiivekkeeseen.

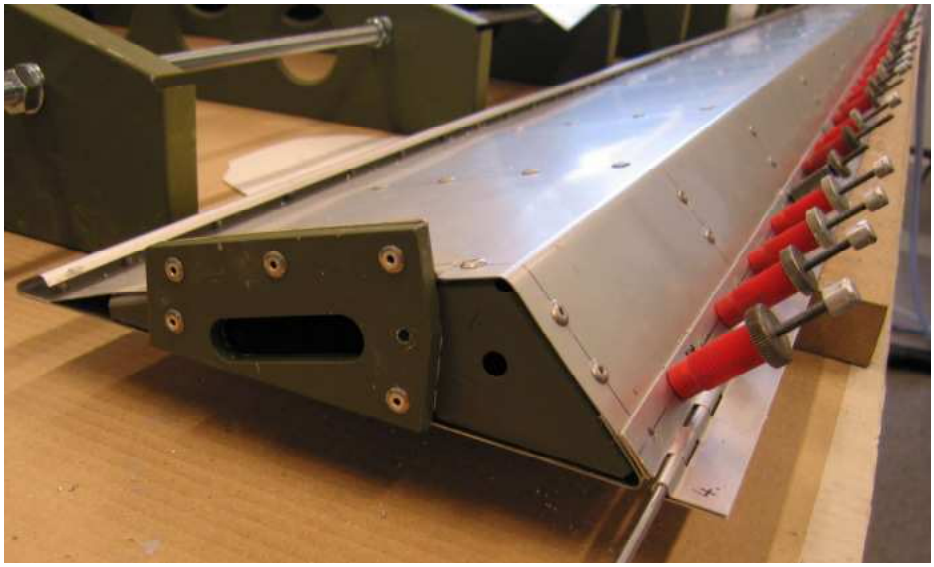


Kuva 32 Saranatapin päätös /1/

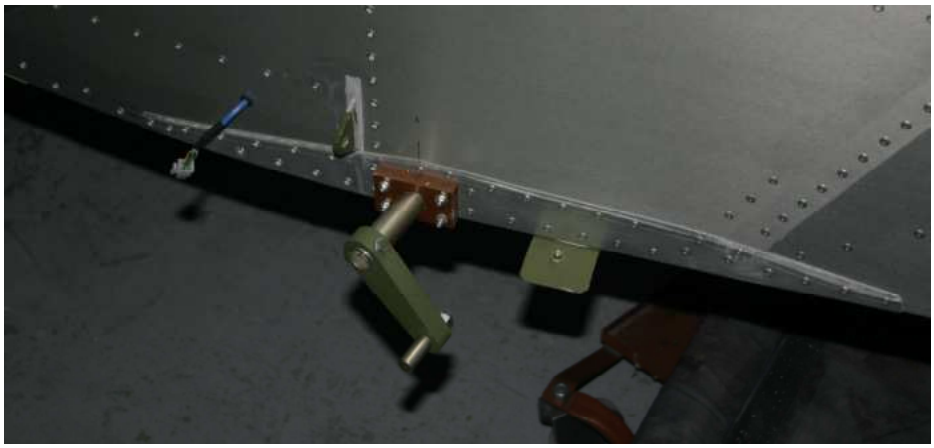
Laskusiivekkeen valmistuksen viimeisenä työvaiheena kiinnitettiin ohjuri (pos. 4) ja kiinnike (pos. 5) laskusiivekkeen siiven tyven puoleiseen päähän Emfimasticilla ja niittaamalla kuten aikaisemmissakin työvaiheissa.



Kuva 33 Laskusiivekkeen ohjurin asennusohje /1/



Kuva 34 Laskusiivekkeen ohjuri paikoillaan



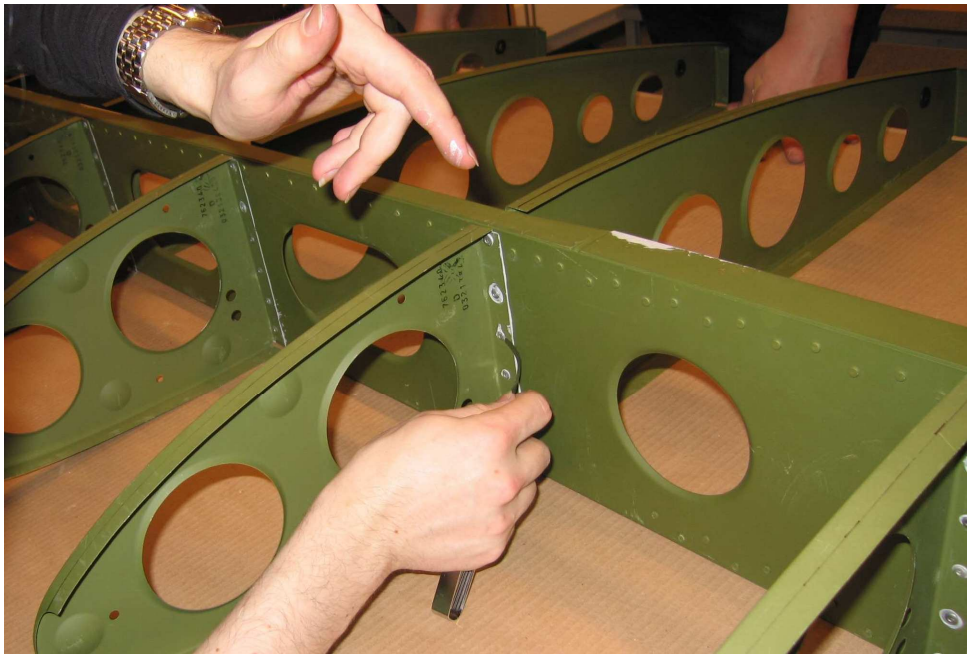
Kuva 35 Laskusiivekkeen käyttövarsi

6.4 Käytetyistä työtavoista

Ohjeitten mukaan niittaus olisi tullut tehdä seuraavassa järjestyksessä: merkintä -> Ø2.5 mm reiän poraus, kiinnitys satiaisilla, esikokoonpano -> purku, jäysteenpoisto -> Emfimasticin levitys pinnoille -> kokoaminen Ø2.5 mm satiaisilla -> Ø3.3 mm reikien poraus -> niittaus

Teimme kuitenkin niittaukset aina kun voimme seuraavassa järjestyksessä: merkintä -> Ø2.5 mm reiän poraus, kiinnitys satiaisilla, esikokoonpano -> Ø3.3 mm reikien poraus -> purku, jäysteenpoisto -> Emfimasticin levitys pinnoille -> kokoaminen Ø3.3 mm satiaisilla -> niittaus

Tämä työjärjestys oli Patrian ammattilaisten neuvoma. Huomattavana etuna siinä oli työvälineiden säilyminen puhtaampina. Ohjeitten suosittamalla työjärjestyksellä tehtäessä ei tosin olisi tarvittu satiaisia kahta eri kokoa.



Kuva 36 Niitin kiinnityksen tarkastaminen rakotulkilla

Siipien kokoamista varten jouduimme erikseen valmistamaan pinnaltaan suorat työpöydät, kummallekin siivelle omansa. Pöydät tehtiin muokkaamalla koulun työpöydistä asentamalla niihin paksu lastulevyinen pintalevy. Lastulevypintaan pystyimme tarvittaessa ruuvaamaan tai naulaamaan osia kiinni.

Useassa kohdassa jouduttiin muokkaamaan valmiiksi pintakäsiteltyjä alumiiniosia, jolloin niihin muodostunut oksidikerros luonnollisesti rikkoutui. Korroosion

estämiseksi tällaiset kohdat käsiteltiin suoja-aineella (kromatointi) ja maalattiin. Maalaus suoritettiin kaksikomponenttimaalilla jota Patria ystävällisesti luovutti käyttöömme.

Kuva 37 Pinnat joista maali on joudutti poistamaan on käsitelty kromatointiaineella, joka tekee pinnan ruskeankeltaiseksi.

Kuva 38 Sama pinta maalattuna

Kromatointi ei ole varsinainen korroosionsuojakäsittely, vaan maalauksen esikäsittely joka parantaa maalin tarttuvuutta alumiinipintaan.

Ennen rakennussarjan saapumista kävimme harjoittelemassa niittaamista Patrian lentokonetehtaalla Jämsän Hallissa.

7. KOELENTO

Koneen ensilento suoritettiin menestyksellisesti helatorstaina 25.5.2006 Pirkkalassa (Tampere-Pirkkala lentokentällä). Seuraamassa koelentoa oli suurin osa projektiin osallistuneista.

Kuva 39 Projektin tulos : valmis kone Pirkkalan lentokentällä keväällä 2006

8.YHTEENVETO JA PÄÄTELMÄT

Ohjaussiivekkeen valmistamisessa tapahtui pieni käännösvirhe. Emme lukeneet työohjetta itse riittävän tarkoin, vaan seurasimme toisen ryhmän työskentelyä, joten huomioimatta jäi seikka että ohjeissa neuvottiin laittamaan painona käytetyn hiekkasäkin alle tarkoitukseen sopiva levy (katso kuva 24). Tämän seurauksena molempien ohjaussiivekkeiden pintalevyt painuivat hieman kaarien välistä. Tämän kuitenkin todettiin olevan tarkastusryhmänkin mielestä lähinnä kosmeettinen ongelma. Laskusiivekettä valmistaessamme muistimme kyseessä olevan ohjeen kohdan ja osasimme toimia niiltä osin oikein.

Molemmissa siivekkeissä erityistä huolellisuutta vaati pintalevyjen niitinreikien poraus. Lähelle kulmia ja jättöreunan puolelle sijoittuvia niitinreikiä porattaessa

piti olla erityisen tarkkana, ettei naarmuttaisi vastapuolen pintalevyä ja täten lisäisi materiaalin korroosioherkkyyttä. Saranoiden niitinreikiä porattaessa oli myös lähes mahdotonta tarkistaa, että reikä tulee juuri oikeaan kohtaan, koska saranan reikiä käytettiin ohjauksena ja niiden lävitse porattiin reiät kahteen levyyn samanaikaisesti. Väistämättä naarmuja syntyi, ja niitä sitten hiottiin pyöreäreunaisiksi säröjen muodostumisen estämiseksi ja sen jälkeen käsiteltiin kromatointiaineella. Naarmut maalattiin niiltä osin kuin ne sijaitsivat sellaisissa paikoissa missä, niihin pääsi tarpeeksi hyvin käsiksi.

Laskusiivekettä koottaessa onnistuimme poraamaan lähes koko saranan niittirivin liian lähelle siivekkeen alapuolen pintalevyn reunaa ja jouduimme tämän valitettavan virheen takia hankkimaan Patrialta uudet pintalevyt toiseen laskusiivekkeeseen.

Lentokoneen kokoamisohjekirja oli tehty mielestäni sillä tavalla, että vähintäänkin jokainen kappale piti lukea ja ymmärtää kokonaisuudessaan, ennen kuin työkaluihin edes ajatteli koskevansa. Monelta alkuvaiheen hammastenkiristelyltä olisi luultavasti vältytty kokoamisohjeisiin hieman huolellisemmin perehtymällä. Myös tämän työn kirjoittamisen aikana sai eräitä kohtia kokoamisohjeesta lukea useampaankin otteeseen, että ymmärsi mitä ”tsekin englannilla” tarkoitettiin. Kokoamisohjekirja oli kuitenkin kattava, ainakin niitten osien osalta joita itse (tai tarkemmin sanoen ryhmä, jonka jäsenenä olin) pääsin kokoamaan.

Joissakin kohdissa tätä työtä viittaan koneen rakennuspiirustuksiin. Rakennepiirustukset ovat Tampereen ammattikorkeakoulun hallussa.

Lentokoneen kokoonpano suoritettiin loppuun 2005-2006 talven aikana Tampereen ammattikorkeakoululla.Koneen rakentamiseen osallistuneet saivat projektista hyvää kokemusta ja näkemystä lentokoneen rakentamisesta ja vaativien projektien läpiviennistä. Jatkoa ajatellen hyvin onnistuneesta projektista saatiin uskallusta ja taitoa seuraavaa lentokoneenrakennusprojektia varten.

LÄHDELUETTELO

Kirjalliset lähteet :

1. EV-97 Eurostar ”2001” Assembly Manual, Evektor Aerotechnik, 6.2001
2. EV-97 Lento-ohjekirja
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5. Evektor Aerotechnik www-sivut, marraskuu 2006
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8. Wikipedia verkkotietosanakirja (suomenkielinen/englanninkielinen), hakusanat: ”Eurostar” , ”ultrakevyt” ja ”ultralight”

LIITTEET

1. EV-97 Eurostar ”2001” Assembly Manual, osat 1-6 ja 12
2. Ilmailumääräys AIR M5-10
3. Lehtiartikkelit rakennusprojektista

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ASSEMBLY MANUAL

EV-97 EUROSTAR

MODEL 2000
version R

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ASSEMBLY MANUAL

EV-97 EUROSTAR

MODEL 2000
version R

Kit Serial Number:

Builder: .....

.....

.....

.....

EVEKTOR - AEROTECHNIK invites suggestions and reminders concerning this manual, and appreciates proposals for corrections.

We invite you to share your experiences with us during the assembly and operation of your ***EV-97 ✰EUROSTAR✰ model 2000 version R***

1. GENERAL

1.1 Record of Revisions

All the important revisions or amendments to this manual shall be issued in the form of bulletins with new pages attached. It is in the interests of every user to enter such revision into the table of revisions and to replace the existing page by the new one. The revised or corrected text shall be indicated by a vertical line on page fore-edge and the page shall bear revision number and date of its issue.

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2	1 16	2, 3, 4 8, 9, 11	03/2003 Valid from S/N 20031701	E097Z221	-	03/2003	Airplane producer
3	1 21	2, 3, 4 12	07/2003 Minor corrections. Valid from S/N 20031708	-	-	07/2003	Airplane producer
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1.3 Table of Contents

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2. INTRODUCTION

2.1 Welcome

Thank you for purchase of your EV-97 EUROSTAR MODEL 2000 VERSION R airplane kit.
The kit producer – EVEKTOR - AEROTECHNIK is renowned Czech aircraft manufacturer with large experience in all-metal aircraft design and production, well-known are above all powered sailplanes L 13 VIVAT operated worldwide in many versions.
The great effort was taken to the ultralight aircraft development, design, and production, recently by reason that liking for those aircraft increases.
Therefore we have prepared for amateur builders the kit of EV-97 EUROSTAR MODEL 2000 VERSION R airplane, that is single-engine, two side-by-side, all-metal low-wing monoplane.
We have done as much as possible to simplify construction of EV-97 and to eliminate the need for special tools, for complicated jigging procedures and for specialized skills.
The purpose of this Manual is to describe you the airplane you are going to build, required tools and technology used for the kit assembly.
The major part of this Manual is devoted to the assembly sequences description.

2.2 Delivered Kit Inspection

If you have the kit shipped to you, the first thing you should do is thoroughly inspect the outside of the crate or cardboard cover for any visible damage that may be occurred in transit. If there is any damage, report it immediately to the shipping company that delivered the crate (cover) to you. Next open the crate (cover) and inspect the contents. There may be no visible outside damage but concealed, inside damage. Even if you do not catch this for several days after taking delivery, it is important that you immediately report any damage in order to process a claim. If there is a claim to file you need to file the claim directly to the freight company from your end. Contact DAC immediately as well. We will assist you with your claim to the greatest extent possible.
After inspecting for damage, you need to jump right into the inventory check. For that purpose we insert into each plastic bag Parts List and a copy is enclosed in this Manual, also.
Going through the inventors not only verifies that all items are enclosed , but also allows you to become familiar with the different parts. It is important that you complete the inventory soon after taking delivery of the kit. Read the Purchase Agreement for the kit warranty, please. If you have any discrepancies contact our representative in the U.S.A or give us a call, e-mail or drop us a note and we will gladly take care of it.

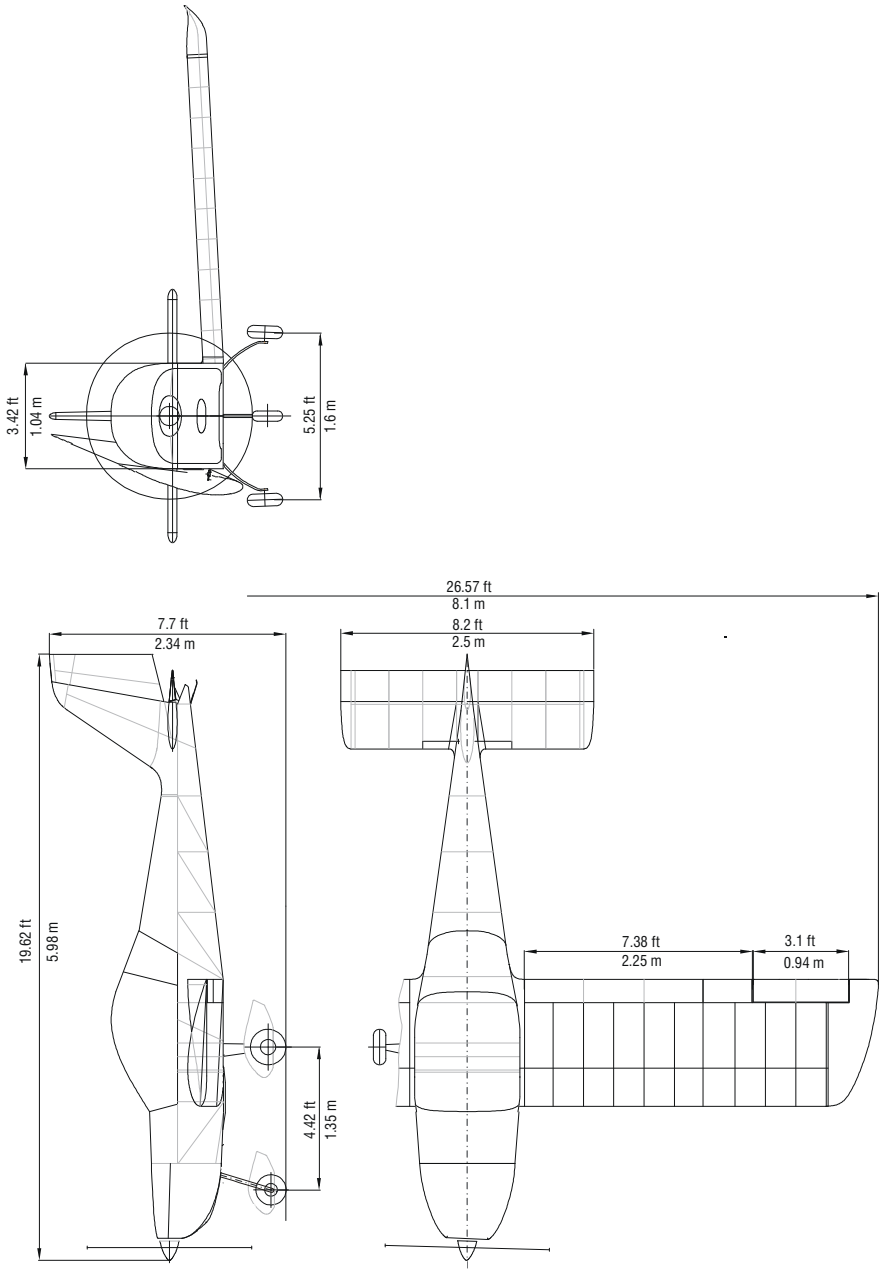
2.3 Builder´s Responsibility

You as the Purchaser/Builder will be totally responsible for the airworthiness of our aircraft. You construct the aircraft and take it to the FAA for receipt of an Airworthiness Certificate. In so doing you are certifying to the FAA that you have inspected all components for airworthiness condition and that you have constructed at least 51% of the aircraft. Be sure you inspect for flaws in material, completion of welding, proper construction and tolerances. You will also be responsible for proper center of Gravity (CG) and flight testing of your EV-97 EUROSTAR MODEL 2000 VERSION R in an FAA assigned test area. Upon completion of the flight testing, you will endorse your Airplane Log Book (supplied in the kit) certifying that you have flown off the prescribed hours and that the aircraft functions properly in all tested flight modes.

2.4 Aircraft Technical Description

EV-97 EUROSTAR MODEL 2000 VERSION R is single-engine, all-metal low wing monoplane of semimonocoque construction with two side-by-side seats. The airplane has fixed tricycle landing gear with steerable nosewheel.
EV-97 EUROSTAR MODEL 2000 VERSION R has been certified in "ULTRALIGHT" category in the Czech Republic, Slovak Republic, and in Germany. The aircraft meets requirements valid for ultralights in most countries.

2.4.1 Three-view Drawing



2.4.2 *Basic Dimensions*

Wing

span	8.1	m	*26.57*	*ft*
area	9.84	m^2	*105.92*	*ft^2*
MAC	1.25	m	*4.10*	*ft*
loading	45.7	kg/m^2	*9.37*	*lbf/ft^2*

Aileron

area	0.21	m^2	*2.26*	*ft^2*

Flap

area	0.52	m^2	*5.60*	*ft^2*

Fuselage

length	5.98	m	*19.62*	*ft*
width	1.04	m	*3.41*	*ft*
overall height	2.34	m	*7.68*	*ft*

HTU

span	2.5	m	*8.20*	*ft*
HTU area	1.95	m^2	*20.99*	*ft^2*
elevator area	0.8	m^2	*8.61*	*ft^2*

VTU

height	1.24	m	*4.07*	*ft*
VTU area	1.0	m^2	*10.76*	*ft^2*
rudder area	0.4	m^2	*4.30*	*ft^2*

Landing gear

wheel track	1.6	m	*5.25*	*ft*
wheel base	1.35	m	*4.42*	*ft*
main wheel diameter	350	mm	*14*	*in*
nose wheel diameter	350	mm	*14*	*in*

2.4.3 Airframe Technical Description

2.4.3.1 General

The EV-97 „EUROSTAR“ airframe is of semi-monocoque construction formed with metal reinforcements, bulkheads and duralumin cover and the pop-rivets are used for joints. Some non-supporting parts are made from fibber-glass.

2.4.3.2 Fuselage

The fuselage has a semi-monocoque construction formed with reinforcements and duralumin covers. The fuselage cross-section is rectangular in the lower section, elliptical in the upper one. The tail fin is an integral part of the fuselage. In the middle section of the fuselage there is a two-men crew cockpit accessible after unfolding the one-part perspex overlap canopy. The engine section in the nose is separated from the crew by a firewall which the engine bed is attached to.

2.4.3.3 Wing

The rectangular wing is a monospar construction with an auxiliary spar for the ailerons and flaps attachments. All the elements are riveted together. At the ends of the wings are riveted fibber glass wing tips. The wing can be equipped with a folding mechanism for a convenient storing in the hangar.

2.4.3.3.1 Ailerons

There is the aileron of the rectangular shape on each half of the wing. The aileron is formed with the ribs and cover, which forms hollow section. The aileron is attached to the wing with the hinge.

2.4.3.3.2 Flaps

Two-third of each wing half is fitted with the split flap. The flaps are of rectangular shape and formed with the ribs and cover, which forms hollow section. The flap is attached to the wing with the hinge.

2.4.3.4 Horizontal tail unit

The HTU consists of a stabilizer and elevator with a trim tab. The semi-monocoque construction of the HTU consists of duralumin ribs, spar and cover. The shape of the HTU is rectangular. The width of 2.5 m enables transport on a sidecar without dismantling.

2.4.3.4.1 Stabilizer

The stabilizer of rectangular shape is formed with duralumin cover and ribs. The stabilizer is attached to the fuselage with two pins at leading edge and secured with two screws at stabilizer trailing edge.

2.4.3.4.2 Elevator

The elevator of rectangular shape is formed with duralumin cover and ribs. The elevator is attached to the stabilizer with the hinge. There is the trim tab hinged at the elevator trailing edge.

2.4.3.4.3 Trim tab

The elevator is equipped with the one trim tab of rectangular shape. The tab is formed with duralumin cover which forms hollow section. The trim tab span is of 2/3 elevator spanwise.

2.4.3.5 Vertical tail unit

The VTU consists of the fin and ruder and has a trapezoidal shape. The rudder is attached on the fin part by two hinges. The frame of the VTU is composed of a metal sheet spar and a duralumin cover.

2.4.3.5.1 Fin

The fin is an integral part of the fuselage rear section and is formed with duralumin spar and cover. The fin tip is formed with the laminated cover, where the anticollision beacon can be installed. The fillet between the fin and rear upper fuselage part is formed with the laminated fillet cover.

2.4.3.5.2 Rudder

The rudder of trapezoidal shape is formed with duralumin spar and cover and attached by two hinges at the fin. The rudder upper tip is formed with laminated cover.

2.4.3.6 Landing gear

2.4.3.6.1 General description

The aeroplane is equipped with fixed tricycle landing gear.

2.4.3.6.2 Main landing gear

The main landing gear consists of the left and right leg. The legs are formed as a fibber-glass springs and are fixed in the fuselage casing under the seats. The main wheels on both legs are equipped with hydraulic disc brakes controlled with brake pedals mounted on rudder pedals. The wheels can be covered with the laminated fairings or mudguards.

2.4.3.7 Nose wheel landing gear

The nose wheel landing gear consists of the leg, fork, yoke with a rubber shock absorber, and a wheel. The standard aeroplane is equipped with steerlable nose wheel, but on a customer's desire may be castered, only. The nose wheel leg is formed from steel tubes welded together and the leg is hinged to the bottom of fuselage front part and supported with a strut attached to the engine bed. The nose wheel fork is welded from steel tubes and spring-loaded with rubber shock absorber inserted in the yoke.

2.4.4 Aircraft Limitations

The EV-97 EUROSTAR MODEL 2000 VERSION R airplane was designed and fully tested to meet the requirements for "ULTRALIGHTS" valid in most countries, but in the U.S.A belongs this airplane to the "EXPERIMENTAL" category with no strict limits for maximum takeoff weight, stall speed, takeoff run etc. and therefore some limits need not be kept so strictly. The design strength of EV-97 is higher than the one, which corresponds to the MTOW 480 kg 1058 lbs (the limit for Ultralight in Slovak Republic and Canada, also).

For your information we explain the following limits resulting from:

- Weight
- Center of Gravity position
- Airspeeds
- Approved maneuvers

CAUTION

Additional limits resulting from the generally valid flight regulations and rules. It is in a builder's interest to become familiar with those regulations, rules and restrictions.

2.4.4.1 Weight

Empty weight (standard equipment)	275	kg ± 3%	*606*	*lbs± 3%*
Maximum Take-off weight	450	kg	*992*	*lbs*
Maximum Landing weight	450	kg	*992*	*lbs*
Maximum fuel weight (65 l fuel tank - standard)	47	kg	*104*	*lbs*
Maximum weight in Baggage Compartment	15	kg	*33*	*lbs*

2.4.4.2 Center of Gravity Position

Empty weight CG (standard equipment)	18±2	% MAC
Operating CG	20-34	% MAC

CAUTION

Weight and CG position limits are valid for standard EV-97 EUROSTAR MODEL 2000 VERSION R airplane i.e. airplane with Rotax 912 engine and prop V 230C installed.

Above shown limits should be considered in case a different powerplant is installed.

We guarantee the flight performance and characteristics only within these limits!

2.4.4.3 Airspeed Limitations

Airspeed limitations and their operational significance are shown below:

Speed		IAS		Remarks
		[km/h]	*[kts]*	
V_{NE}	Never exceed speed	270	*146*	Do not exceed this speed in any operation.
V_{NO}	Maximum structural cruising speed	190	*103*	Do not exceed this speed except in smooth air, and then only with caution.
V_A	Maneuvering speed	160	*86*	Do not make full or abrupt control movement above this speed, because under certain conditions the aircraft may be overstressed by full control movement.
V_{FE}	Maximum Flap Extending speed	125	*67*	Do not exceed this speed with flaps extended

See Airplane Flight Manual, Section 5 "Performance" (AFM is supplied in your kit) for pitot-static system calibration, position error and Calibrated Airspeed (CAS)

2.4.4.4 Approved Manoeuvres

Airplane Category: "ULTRALIGHT" not valid for U.S.A
"EXPERIMENTAL" U.S.A

The EV-97 „EUROSTAR" airplane is approved for normal and below listed manoeuvres:
Steep turns not exceeding 60° bank
Lazy eight
Chandelles

WARNING
No Aerobatics and intentional spins!

2.5 Aircraft Kit Description

2.5.1 Airframe Kit

By purchasing the standard EV-97 EUROSTAR MODEL 2000 VERSION R airplane kit you will obtain all the parts necessary to built airframe of your EUROSTAR.

To complete your airplane you should buy and install required parts not supplied in the kit, i.e. engine, flight, navigation, and engine instruments or other equipment depending on your option. Refer to the 2.5.2 for Required Parts Not Supplied in the Kit.

List of parts supplied in the kit is included not only in the kit packing, but also in this Manual – see pages enclosed at the ends of Sections describing assembly sequences of airframe major parts (Aileron, Flap, Wing etc.).

You can also contact us and order optional equipment for your EUROSTAR. See our home page http://www.evektor.cz to know our current offer.

2.5.1.1 Documents supplied with the standard kit

You will obtain with your kit not only this Assembly Manual but also the following documents:

- Airplane Flight Manual (as Microsoft Word document on enclosed CD-ROM)
- Technical Description, Operating, Maintenance and Repair Manual for EV-97 EUROSTAR MODEL 2000 VERSION R Airplane (as Microsoft Word document on enclosed CD-ROM)
- Airplane Log Book
- Assembly Log Book
- Statement of Quality of Structural Materials

2.5.2 Required Parts Not Supplied In The Kit

The standard EV-97 EUROSTAR MODEL 2000 VERSION R kit supplies most parts necessary to build the airframe but not all parts needed to build the entire airplane.

Additional parts and components you will need include an engine, a propeller, avionics, and flight and engine instruments. All of these, as well as various optional components that you might choose to configure your airplane just the way you want it, are available from us.

If you choose not to install components and options offered and supported by us, you are responsible for finding sources of those components and working out the details of their installation.

You will need also tools and instruments to assemble your airplane. If you have problems to get same tools (e.g. metric system tools etc.) we can supply you.

2.6 Customer Support

With any project of this size, questions will almost certainly arise.
There is impossible to foresee all the questions which may arise and describe them in this Assembly Manual, but we want to assure you at the start that we will provide the best support possible.

If you have any questions, please do not hesitate and contact us at the address:

EVEKTOR - AEROTECHNIK
686 04 Kunovice
Czech Republic
Tel.: + 420 572 537 316
Fax: + 420 572 537 900
E-mail: marketing@evektor.cz

Working hours: Monday-Friday 07:00 – 15:00 CET

See also EVEKTOR - AEROTECHNIK Home page: http://www.evektor.cz
for more information about our company, offer of our products, kit assembly etc.

2.7 Recommended Reading

Although "SECTION II: TOOLS AND TECHNIQUES" provides a fairly complete description of the various aircraft construction procedures needed to assemble the EUROSTAR, we recommend supplementing the information provided in that section with readings from the following list of books, which address the subject of airplane construction in greater detail. The handbooks listed are especially good for the amount of information they condense into a small package. We also recommend the various homebuilt airplane periodicals-especially *Sport Aviation* (which is sent to members of Experimental Aircraft Association - EAA) and *Kítplanes.* In addition, browsing through some of the aircraft tool and supply catalogs, such as the Aircraft Spruce and Specialty catalog (800-824-1930), can provide a lot of insight into aircraft construction practices.

- Bent, Ralph D., and James L. McKinley. Aircraft Maintenance and Repair, 4th ed. New York: McGraw-Hill Book Company.
- Maintenance and Repair of Aerospace Vehicles. New York: McGraw-Hill Book Company.
- Powerplants for Aerospace Vehicles. New York: McGraw-Hill Book Company. Bingelis, Tony. Fírewall Forward; Engine Installation Methods. Oshkosh, WI: EAA Aviation Foundation, Inc.
- The Sportplane Builder: Aircraft Construction Methods. Oshkosh, WI: EAA Aviation Foundation, Inc.
- Sportplane Construction Technicues. A Builders Handbook. Oshkosh, WI: EAA Aviation Foundation, Inc.
- Reithmaier, Larry, ed. Standard Aircraft Handbook. Blue Ridge Summit, PA: Tab Aero Books.
- Standard Aviation Maintenance Handbook. Casper, WY: IAP, Inc.
- U.S. Department of Transportation, Federal Aviation Administration. Airframe & Powerplant Mechanics: Airframe Handbook. Washington, D.C.: U.S. Government Printing Office.
- Airframe & Powerplant Mechanics.; Powerplant Handbook, Washington, D.C.: U.S. Government Printing Office.
- EA-AC 43.13-1A & 2A, Acceptable Methods, Techniques, and Practices: Aircraft lnspection and Repair – Aircraft *Alterations.* Washington, D.C.: U.S. Government Printing Office.

We recommend you the following Advisory Circulars (AC), also:

- AC 20-27D Certification and Operation of Amateur-Built Aircraft
- AC 20-139 Commercial Assistance During Construction of Amateur-Built Aircraft
- AC 21-12A Application for U.S.Airworthiness Certificate, FAA Form 8130-6
- AC 39-7C Airworthiness Directives
- AC 43.13-1A Acceptable Methods, Techniques and Practices Aircraft Inspection and Repair
- AC 43.13-2A Acceptable Methods, Techniques, and Practices - Aircraft Alterations
- AC 65-23A Certification of Repairmen (Experimental Aircraft Builders)
- AC 90-89A Amateur-Built Aircraft and Ultralight Flight Testing Handbook
- AC 103-7 The Ultralight Vehicle

Above listed AC can be obtained from:

U.S. Department of Transportation
Utilization and Storage Section M-443.2
Washington, D.C. 205 90

There are some AC published also on Internet.

2.8 Using the Assembly Manual

EV-97 EUROSTAR MODEL 2000 VERSION R airplane kit Assembly Manual is divided into a number of Sections.

At the beginning are introduced general information concerning airplane and kit description, and some important suggestions to know prior to beginning airplane building sequences.

Then follows the Section concerning Tools and Techniques used to assemble the kit.

The main part of this Assembly Manual is devoted to the airplane assembly sequences. Sections describing the various sub-assemblies of the airplane follow in the recommended order of completion.
None of the procedures described here are difficult to learn, especially if you have some experience using basic shop and power tools. If a particular procedure is new to you, however, practice on scrap material to develop your skill before risking damage to the airframe components. To help you with this, we have supplied a "**LEARNING KIT**"in your EV-97 EUROSTAR MODEL 2000 VERSION R kit. The Learning kit plastic bag consists of small pieces of aluminum sheet of various thickness, rivets, nuts a plexiglass piece etc., so you can practice procedures such as riveting, dimpling, countersinking, cutting, nutplate installation and so on. Then follows with a simpler part assembly e.g. assemble the aileron.

There are also described important instructions keep in mind prior to powerplant installation, during airplane final assembly, some insformation concerning airplane registration procedure in the U.S.A, and Flight tests execution.

The last section "APPENDICES" includes additional information, Records for leveling, weighing etc., i.e. information included to help you with your kit assembly and putting of your EUROSTAR into operation.

2.8.1 Warnings, Cautions, Notes and Hints

The following definitions apply to the **WARNINGS, CAUTIONS, NOTES** and **HINTS** used throughout this Assembly Manual. Warnings, Cautions, Notes and Hints appear in the format shown here.

WARNING

A warning is used to alert you to a procedure, a practice or a situation that may result in personal injury or loss of life if not carefully followed or strictly observed..

CAUTION

A caution alerts you to a procedure, a practice or a situation that, if not carefully followed or strictly observed, may result in damage to or destruction of a part..

NOTE

A note alerts you to a step, a procedure, or an instruction that is considered important to emphasize.

HINT

A hint is a recommendation for an easy way to accomplish a certain procedure.

2.8.2 Dimensions and Tolerances

Dimensions given throughout this Assembly Manual are mostly in strandard metric system, because of "European origin" of this airplane.
For builders in countries that do not use the metric system, we recommend procuring a set of metric-system measuring tools (tapes , rules, drill bits etc.) and becoming familiar with their use rather than converting from metric to English measurements. We feel that it is better to maintain consistency and use the metric system throughout because converting between systems is an unnecessary, time-consuming step that introduces one more opportunity for errors to occur.

2.8.3 Illustrations

Sketches, figures, drawings, and photos are shown in this Assembly Manual. List of drawings required to assemble a part of airframe is listed at the beginning of each sub-assembly section and in the last section APPENDICES, also.
Parts shown in the illustrations are referenced by the key number that appears in the Parts List at the end of the section.

2.8.4 Assembly Manual Revisions

Each EV-97 EUROSTAR MODEL 2000 VERSION R builder is supplied with up-dated and valid Assembly Manual.
The important and Mandatory changes and/or corrections concerned to the Manuals still issued shall be issued and sent to the builders in form of the bulletins with new pages enclosed.
It is in the interests of every builder to enter such revision into the table of revisions in 1.1 Record of Revisions and to replace the existing page by the new one. The revised or corrected text shall be indicated by a vertical line on page fore-edge and the page shall bear revision number and date of its issue.

2.8.5 Kit Assembly Sequence

The kit assembly sequences in this manual have the uniform structure of the following format:

Title of a part assembled
The title of a sub-assembly (e.g. Aileron, Flap etc.) is stated together with a Section number at the beginning of each section on a separate list.

1.1 Illustration
Illustration helps you to imagine the parts from which the airplane sub-assembly consists on.

1.2 Parts List
List of parts required to assemble the airplane sub-assembly is enclosed at the end of each section describing the assembly sequence.

1.3 Workspace
Described is workspace required to build a sub-assembly, e.g. worktable etc..

1.4 List of Drawings
Listed are drawings required for build a sub-assembly.

1.5 Required Tools and Instruments List
Required tools and instruments are listed in a table, a number of pieces is included, too. Additional materials such as adhesives, sealants, colors etc. are listed in that table, also.

1.6 Assembly Outline
The main objective of Assembly Outline is to help a builder get to know the operations which should be followed to assemble a part of airplane. The operations consist of series of steps.

1.7 Detailed Assembly Sequence
The assembly outlines are described in detail. The operations consist of series of numbered step. There is a line “Completed : [ ]“ at the end of each step to check after completion. This helps you to know where you are if you break assembly for a time.

NOTE
We strongly recommend you to photograph the construction process especially the interior structure prior to riveting the skins.

2.9 General Assembly Considerations

Before beginning any construction, consider the following general instructions:

1. We suggest studying each of the individual assembly sections before beginning work on that assembly. By acquiring a thorough understanding of what is to be accomplished before beginning work, you will avoid surprises and help prevent costly and time-consuming mistakes.
2. Make sure all the tools and materials required are on hand.
3. Proceed in a stepwise manner paying close attention to the Warnings, Cautions and Notes.
4. After completing each step in the individual assembly sections, check the space marked "Completed: [ ]." Also, when you have completed each major sequence of steps, sign and date the appropriate line on the Assembly Log pages (Assembly Log is supplied in the kit). If you do this, you will always know where you are in the construction sequence and where you ended your previous work session. This will also provide some of the documentation required by the FAA that you, yourself, accomplished the major portion of the work to assemble the EUROSTAR airframe.

2.10 Kit Storage

Because most builders can work on just one part of the airframe at any one time, the other parts must be stored until they are needed. Sheet metal, fiberglass and acrylic plastic (Plexiglass) components are subject to damage or deterioration if stored improperly.
Need the following suggestions for storing these parts.

2.10.1 Sheet Metal Parts Storage

The sheet metal airframe components, such as the spars, ribs and skins, are subject to damage by deformation, by scratching and by corrosion. Take care, when storing these parts, not to pile heavier parts on top of them that might deform them, rendering them unusable. Store pre-bent skins on top of other components, for example, so that heavier parts do not tend to change the radius of the bends. Put small components in boxes or other packaging to protect them until needed. If a protective paper or plastic coating is present on sheet aluminum parts, leave it on until the parts are needed.

CAUTION

Be very careful and take your time when removing the protective covering from aluminum sheets. If you pull too hard in the wrong direction, you could permanently crease or kink the sheet. To remove the covering, start from one end and then hold that end down while pulling the covering low and parallel to the surface. Do not pull the covering up perpendicular to the surface. Additionally, take care when picking up large pieces of sheet metal (like the skins, for example) that have a joggle or a bend in one edge. If you allow the sheet to flex perpendicular to the bent edge, you will crease it, and such creases are difficult or impossible to remove.
When aluminum is alloyed with various other metals, its stiffness and strength is increased dramatically but its corrosion resistance is reduced. So, a thin coat or "cladding" of pure aluminum (which is much more corrosion-resistant than aluminum alloy) is often applied to the surface of aluminum alloy sheets. All of the sheet metal skins in the EUROSTAR are made from this "Alclad" aluminum alloy. Because pure aluminum is very soft, the surfaces of Alclad sheets are easily scratched. Scratches that penetrate just the protective cladding have little effect on the strength of the sheet, but they do reduce its corrosion-resistance.
Deeper scratches on sheet metal components provide places where stresses concentrate, which can reduce the strength of the parts and their tolerance to fatigue. Be very careful, therefore, to prevent scratches on sheet metal parts. If scratches occur, remove them with wet sandpaper: 600 grit for small scratches; 400 grit followed by 600 grit for deeper scratches. To prevent scratches, store the parts in an out-of-the-way place where they are not subject to routine contact from other parts or from tools while you are working in your shop.
Keep sheet metal components in a dry place to help prevent corrosion. Aluminum parts that are continuously damp, especially if in contact with dissimilar metals, can be ruined by corrosion in a very short time. Do not store metal parts in close proximity to corrosive chemicals, such as battery electrolyte or powerful cleaning compounds. Even the vapors from such chemicals, if confined to a closed space, can induce corrosion of metal parts.
The same storage and handling precautions apply to finished aluminum airframe components. Once you have finished the components, find a place to store them where they are safe from damage while you are working on other parts.

2.10.2 Fiberglass Parts Storage

Fiberglass airframe components, individually, do not have the structural integrity of a completed assembly. Until riveted together into an integral structure, fiberglass parts are free to bend and adapt to any shape to which they are subjected. If stored for an extended period in a deformed condition (especially at higher temperatures), "sets" can occur in the fiberglass parts, which will complicate assembly of the parts. Proper storage is mandatory, therefore, to keep the parts from warping or taking on sets.
The best place to store the parts is in the shipping crate or carboard cover itself. If the parts cannot be stored in the crate, make sure the parts are stored in an un-deformed condition.

NOTE

If parts do become warped they can be corrected by applying pressure over a period of time in a direction opposite the set. Careful application of heat is also helpful.
Also, protect the unfinished interior surfaces of fiberglass components from long-term exposure to direct sunlight. Over time, the ultraviolet light in sunlight can cause the plastic resin in unprotected fiberglass parts to deteriorate, which can seriously weaken the parts. The exterior surfaces of all fiberglass components supplied for the EUROSTAR kit are painted to provide protection from the harmful effects of ultraviolet light..

2.10.3 Perspex Canopy Storage

Protect acrylic plastic parts (the front and rear cockpit canopy, and the cabin windows) from contact with sharp parts that could scratch them. Leave as much as possible of the protective covering on these parts until airframe assembly is complete. Acrylic plastic components can become warped if stored in a deformed condition, especially if subjected to elevated temperatures..

2.10.3.1.1 Canopy Cleaning

The canopy clean only by washing it with a sufficient quantity of lukewarm water and adequate quantity of a detergents, with clean and soft cloth sponge or deerskin. Then use suitable polishers to clean the canopy.

CAUTION

Never clean the canopy under „dry“ conditions and never use gasoline or chemical solvents!

2.11 Safety Precautions

WARNING

For personal safety, please read and heed the following safety precautions. Some of the materials and processes discussed below rnay be unfamiliar to you, but we believe it's important that you acquaint yourself with potential hazards before you encounter them. All the materials and processes discussed here will be fully explained in Section 3.Tools and techniques. Refer back to this "Safety Precautions" section when you begin working with a new material or process.

2.11.1 Recommended Safety Equipment

- Suitable work clothes – it should not be too slack (a slack work clothes may catch into rotaring machines) and prefereble is the one that covers main part of your body (protection against the skin contamination etc.)
- Working boots – proof is prefferable
- Goggles – to prevent eye contamination during sanding etc.
- Glovers

2.11.2 Eye and Skin Contamination

To prevent potential eye contamination we strongly recommed to use suitable goggles during all operations when particles arise.
Other potential hazard is a use of chemicals – thinners, colors, solvents, gasoline etc.
We recommned you to keep an eyewash bottle filled with clean water close at hand and in case of eye contamination immediately to flush the eye with plenty of clear water and see a physician.
Above mentioned suitable work clothes is highly recommended.

2.11.2.1 Additional Safety Equipment

- First Aid Kit
- The address and phone number of the nearest hospital or a physician
- Clean water – to flush the eye or skin immediately after its contamination

2.11.3 Vapors and Dust Particles

Avoid breathing the fiberglass particles while sanding or fíling fiberglass. Use a good quality particle mask, available at most hardware stores.
Ensure well-ventilated area when using chemicals with hazard vapors. Avoid breathing these vapors when high concentrations exist. We recommend wearing a vapor respirator (available at most hardware stores) for protection.
In case of headache, nausea etc. immediately break your work and leave the room to breath fresh air. Visit a physician in case of long-standing health troubles.

2.11.4 Flammabilities

Most chemicals are flammabilities of high grade and therefore proper use is very important.
Keep the instructions described on the containers of those chemicals. Keep the chemicals away from direct sunlight, heat, sparks, open flame, and reach of children.
Keep track of all materials and store them in a cool, clean, well-ventilated area. Make sure all containers are sealed when not in use. Empty containers should be depreciated in compliance with legal regulations to prevent from water and ground contamination.
We recommend you to have in reach an extinguisher fire and to be familiar with its proper use.

2.11.5 A Final Word about Safety

We feel it is vitally important that you be aware of the potential hazards associated with aircraft construction from the beginning.
However, the preceding catalogue of dangers can sound rather overwhelming, and it is worth emphasizing that the experience of building your EUROSTAR will be safe and enjoyable as long as you follow the few, simple precautions outlined above. Like flying itself, building an airplane can be extremely safe as long as safety isn't taken for granted.

2.12 Aviation Authority Inspection and Documentation Requirements

The FAA requires that certain documents and records be kept, including records of pre-cover inspection, during construction of a homebuilt aircraft. These requirements are detailed in FAA Advisory Circular 20-27D, which is available (free of charge) from:

U.S. Department of Transportation
Utilization and Storage Section M-443.2
Washington, D.C. 205 90 available in INTERNET, also

This is a brief outline of the major points covered in AC 20-27D, but we strongly encourage you to procure and review a copy of the circular early in your construction schedule. First, the builder must keep copies of invoices, receipts and shipping documents for materials and kits used in construction of the aircraft. The FAA inspector will want to see these documents when inspecting the finished aircraft prior to issuance of an airworthiness certificate.

The builder must also keep a log of the construction and inspection of the aircraft as it is built. The Assembly Log at the end of this section is designed to help satisfy this requirement, but you should carefully study AC 20-27D to ensure that you meet all FAA logging requirements.

The FAA no longer performs so-called "pre-cover inspections" of the interior structure of homebuilts. However, pre-cover inspections performed by some knowledgeable person (such as the builder himself or an EAA designee) are still required and must be recorded in the construction log. As additional evidence of pre-cover inspection, many builders photograph the construction process as they build, and we strongly endorse this practice.

The FAA will perform a final inspection of the aircraft before flight. In addition to inspecting the aircraft itself, the FAA will inspect the above-mentioned documents and records. If the aircraft passes the inspection, and the necessary documents and records are in order, the inspector will issue a limited airworthiness certificate for a specific test period and area.

The flight history of the aircraft during the specified test period must be recorded in a flight log. Record the length of each flight, the tests performed and the outcome of the tests. Document any problems encountered during test flights and the steps taken to resolve the problems.

After the flight test period has been flown off, the builder should present the construction and flight logs and the old limited airworthiness certificate to the FAA for issuance of an unlimited airworthiness certificate. If all the records are in order, the FAA will not inspect the aircraft at this time.

If you have any questions concerning registration and certification we suggest contacting the local FAA General Aviation District Office (GADO) or Flight Standards District Office (FSDO).

2.13 Aircraft Registration Procedures

The Federal Aviation Regulations (FAR) require that all U.S. civil aircraft be registered before an airworthiness certificate can be issued. FAR Part 47, Aircraft Registration, prescribes the requirements for registering civil aircraft. The basic procedures are as follows:

1. Before an amateur-built aircraft can be registered, the builder must first obtain an identification number that will eventually be displayed on the aircraft. About six months before you anticipated first flight, request assignment of an identification number by writing to:
   FAA Aircraft Registration Branch Attn.: Central Records Department of Transportation
   P.O. Box 25504, Oklahoma City, OK 73125
   Your request must include the following information: the manufacturer of the airplane (your name!), the make (EUROSTAR), the model number (EV-97), the serial number (your EUROSTAR kit number), your name, address, telephone number and signature. You must also enclose a check for the $ 10.00 fee.
   If you want a personalised "N" number assigned to your aircraft, specify five choices in order of preference. Alternatively, you can telephone the FAA in Oklahoma City at (405) 954-31 16 to find out if a particular number is available. A personalised identification number costs an additional $ 10.00, so a check for this amount must be included with your letter of request. There is no extra charge for a random identification number. Within a few weeks of receiving your application, the Aircraft Registry will send you a form letter giving your assigned number, a blank Aircraft Registration Application (AC Form 8050-1) and other registration information.
2. Before you can get an Airworthiness Certificate, you must have an Aircraft Registration Certificate. So, about four months before your first flight, send the following information to the Aircraft Registry:
   a) The letter you received with your identification number assignment.
   b) A completed Aircraft Registration Application, FAA Form 8050-1 .
   c) A completed Affidavit of Ownership-Amateur-Built Aircraft, FAA Form 805088.
   d) A completed Eligibility Statement for Amateur-Built Aircraft, FAA Form 81 30 12.

NOTE

We recommend you to read AC 20-27D – Certification and Operation of Amateur-Built Aircraft

2.14 Airworthiness Certification

After one hour of taxi testing has been logged on the finished aircraft, it is time to submit your Application for Airworthiness Certificate and to request an inspection by the FAA. Contact your local FSDO to request an inspection.

So as not to waste the FAA inspector's time (and possibly evoke his or her ire!), you should be absolutely certain that the airplane is ready when you call for the inspection. We recommend having an independent inspection performed by a knowledgeable person, such as an EAA designee, before calling for the FAA inspector. Often, builders are so close to their projects that they inadvertently overlook deficiencies that are obvious to an unbiased observer.

Remedy any deficiencies uncovered by your independent inspector before the FAA inspector arrives, or else the Airworthiness Certificate could be denied. Keep in mind that the primary objective of the inspections is not just to verify compliance with the law, but to ensure safety.

In addition to inspecting for acceptable workmanship and construction practices, the FAA inspector will check the airplane for the minimum required instrumentation (see FAR 91 .33), instrument range markings, ELT installation, pilot and passenger restraints, properly marked "N" number and the appropriate, permanently installed placards.

The placards required for certification of an experimental, amateur-built aircraft are:

1. The word "**EXPERIMENTAL**" in 2" high block letters, displayed near each entrance to the cabin.
2. A permanently installed, fireproof identification plate that is indelibly stamped or engraved with the information required by FAR 45.1 3. The data plate must be located on the exterior of the aircraft, either just aft of the canopy or on the fuselage near the tail surfaces, and must be legible to a person standing on the ground.
3. A Passenger Warning Placard, permanently installed in the cockpit in full view of all the occupants with the words:

PASSENGER WARNING
THIS AIRCRAFT IS AMATEUR BUILT AND DOES NOT COMPLY WITH FEDERAL SAFETY REGULATIONS FOR "STANDARD AIRCRAFT"

Also, have the following documents ready for the inspector:

1. An Application for Airworthiness Certificate, FAA Form 8130-6.
2. Enough data (such as photographs or a three-view drawing) to identify the aircraft type. (The three-view drawings at the beginning of this Assembly Manual would suffice.)
3. An Aircraft Registration Certificate, AC Form 8050-3, or the pink copy of the Aircraft Registration Application, AC Form 8050-1.
4. A statement setting forth the purpose for which the aircraft is to be used. In "governments," your purpose is most likely to be: "Operating an amateur-built aircraft." (Other possibilities include "Exhibition" and "Air Racing.") The statement should also state the estimated duration of the test period and the areas over which the test will take place. Call your GADO or FSDO for guidance.
5. A notarised statement that the applicant, a) fabricated and assembled the major portion of the aircraft for educational or recreational purposes and, b) has evidence to support the statement available to the FAA upon request. This is where photographs of construction in progress will provide a good supplement to your Assembly Log.
6. Weight and balance data on the finished aircraft.
7. An airplane log book with evidence of inspections, such as log book entries signed by the builder, describing all inspections conducted during construction of the aircraft. This will substantiate that the construction has been accomplished in accordance with acceptable workmanship methods, techniques, and practices. The Assembly Manual with completion of each section signed off in the Assembly Log will suffice.

If no deficiencies are found in the aircraft, and if all the documents are in order, you will be issued a Limited Duration Experimental Airworthiness Certificate and Operating Limitations that will permit you to begin flight testing.

The regulations and paperwork required to get your EUROSTAR airborne can be daunting in their number and complexity. In general, we would advise you to establish a relationship with your local FSDO early in the construction process and to maintain it through final airworthiness certification. Things are likely to go much more smoothly if you do.

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3. TOOLS AND TECHNIQUES

3.1 Introduction

This section of the Assembly Manual describes the tools and construction techniques required to build the EV-97 EUROSTAR MODEL 2000 VERSION R. It describes metal fabrication, riveting, fiberglass parts adjustment and other fabrication procedures. Refer to this section frequently when fabricating the individual assemblies described later.

None of the procedures described here are difficult to learn, especially if you have some experience using basic shop and power tools. If a particular procedure is new to you, however, practice on scrap material to develop your skill before risking damage to the airframe components. To help you with this, we have supplied a plastic bag named "Learning kit" in your EUROSTAR kit. The kit consists of small pieces of aluminum sheet of various thickness so you can practice procedures such as riveting, cutting, dimpling and countersinking etc. The bag containts also small amounts of rivets, nutplates, a piece of plexiglass and some other parts.

Besides studying the techniques described here, also refer to the publications listed under 2.7 Recommended Reading. This is your opportunity to learn as much as possible about aircraft fabrication in order to build the best EUROSTAR that you can.

3.2 Materials Used in the Kit

The structural materials i.e. steel and duraluminum sheets, rods, tubes, fasteners and cables supplied in the kit of EV-97 EUROSTAR MODEL 2000 VERSION R airplane conform to the generally valid requirements, rules, and standard specifications applied to the aircraft construction materials.
Refer to the STATEMENT OF QUALITY OF STRUCTURAL MATERIALS supplied in the kit.
Semi-manufactured parts are professionally made to make easy the kit assembly without need for special tools and jigging.

3.2.1 Metallurgical Materials Used for EV-97 Kit Construction

No.	Material	Marking in the kit documentation	U.S.A equivalent
1.	Chrome-molybdenum high-quality steel (especially suitable for welding and heat treatment)	L – CM 3	4130 H
2.	Chromo-manganese-silicon high-quality steel (Suitable for heat treatment)	L - ROL	None
3.	Chrome-nickel stainless high-quality steel	L – AKVS	321 H
4.	Al-Cu-Mg 1 Aluminum alloy (airframe parts)	Z 42 42 53 Clad sheets	ALCLAD 2024
		Z 42 42 03 bars, tubes, profiles	2024
5.	Al-Mg 1 Aluminum alloy (welded aluminum parts)	Z 42 44 00	6061
6.	Al-Mg 2,5 Aluminum alloy (manifold)	Z 42 44 12	5052
7.	Al-Mn1-Cu Aluminum alloy (the fuel tank)	Z 42 44 32	3003
8.	Al-Cu4-Mn Aluminum alloy (rivets)	Z 42 42 08	None (2017 A – harden prior riveting)
9.	Al-Si Aluminum alloy (castings)	Z 42 43 34.7	A 356.0

3.2.2 Fasteners

The following discussion is a brief description of the most common fasteners used in assembling the EV-97 EUROSTAR MODEL 2000 VERSION R. This information is intended to assist the builder in identifying the different hardware supplied with the kit and to provide some general guidelines for its proper use. If you are a first-time builder or an amateur mechanic, we strongly recommend procuring an aviation mechanic's general handbook for a more detailed discussion of this subject.
Refer to the last Section "APPENDICES" for detailed list of fasteners supplied in the EV-97 EUROSTAR MODEL 2000 VERSION R.

NOTE
All the fasteners used for kit assembly are in Metric system.

3.2.2.1 Rivets

3.2.2.1.1 Blind rivets

Most rivets used to assemble the EV-97 EUROSTAR MODEL 2000 VERSION R kit are Blind rivets manufactured by AVEX Company. These rivets are called "blind rivets" because the shop head is not visible during or after forming. They are also called "pull rivets" because the shop head is formed by pulling a solid mandrel into the hollow rivet shank from the accessible side.
Refer to the last Section “APPENDICES” for detailed list of rivets supplied in the EV-97 EUROSTAR MODEL 2000 VERSION R kit.

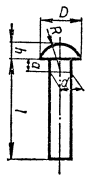
Fig. AVEX Blind rivets

WARNING
Do not use standard, hardware-store Pop rivets in the EV-97 EUROSTAR MODEL 2000 VERSION Rairframe. Use only rivets supplied in the kit.

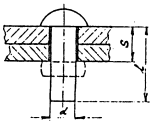
3.2.2.1.2 Solid shank rivets

Some parts of airframe (e.g. wing spars) are riveted with Solid shank rivets. Most parts riveted with these rivets are supplied in the kit already completed but there are some parts to be riveted (e.g. cockpit canopy).
Therefore not only Blind riveting but also a “Standard” one is described below in this section.

The rivets supplied in the kit are shown in the following figure:

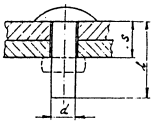


Rivet 3x7 ČSN 022301.7



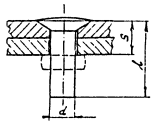
5DuK 3x10P

Rivet 3x10 ČSN 022302.5



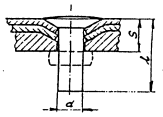
5DuV 3x10P

Rivet 3x10 ČSN 022304.5



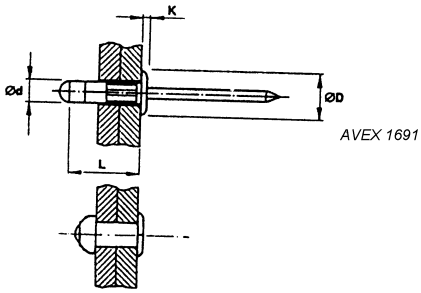
5DuZ 3x10P

Rivet 3x10 ČSN 022320.5

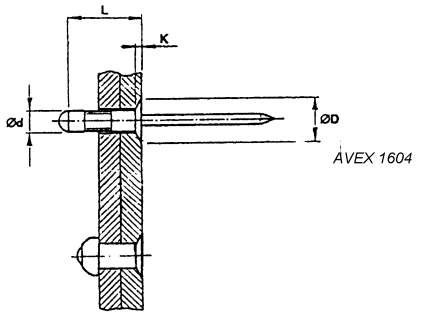


5DuZz 3x10P

Rivet 3x10 ČSN 022320.5



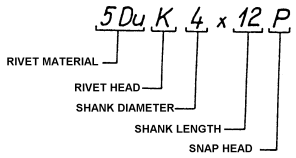
AVEX 1691



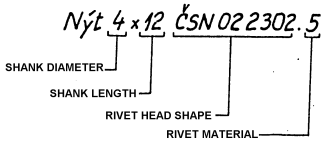
AVEX 1604

SOLID RIVET INDICATION

1. ON DRAWINGS



2. IN LISTS



RIVET MATERIAL INDICATION

RIVET MATERIAL ČSN	RIVET MATERIAL GOST	INDICATION ON DRAWINGS	SUPPLEM. DIGIT
42 4204.6	D 18P	Du	.0
42 4005.2	AL 99,5	1 AL	.1
42 4415.1	AMg 5	2 Mg	.2
42 4432.1	AMc	3 Ac	.3
42 4201.6	D1P	4 Du	.4
42 4208.7	V65	5 Du	.5
42 4203.6	D 16P	6 Du	.6
11 341.1	15A (10)	Oc	.7

3.2.2.2 Bolts

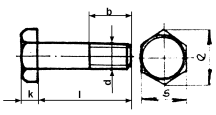
With very few exceptions, the bolts used in the EUROSTAR are standard, general-purpose, aircraft-grade bolts.

Follow the instructions in this manual and in drawings and use a bolt of proper type, size, and diameter for a threaded joint. A small plastic bag with all the necessary fasteners (including bolts) is inserted into each sub-assembly bag.

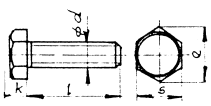
Refer to the last Section "APPENDICES" for detailed list of bolts and screws supplied in the EV-97 EUROSTAR MODEL 2000 VERSION R kit.

The bolts and screws supplied in the kit of EV-97 EUROSTAR MODEL 2000 VERSION R airplane are shown on the Figures below, the explanation of symbols and supplementary digit meaning follows the figures.

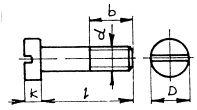
ČSN 02 1101.xx



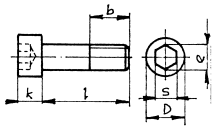
ČSN 02 1103.xx



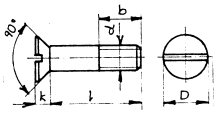
ČSN 02 1131.xx



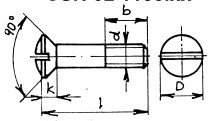
ČSN 02 1143.xx



ČSN 02 1151.xx

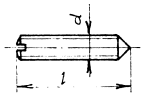


ČSN 02 1155.xx

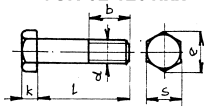


ČSN 02 1181.xx

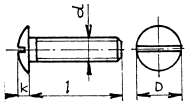
ČSN 02 1185.xx



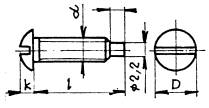
ČSN 02 1201.xx



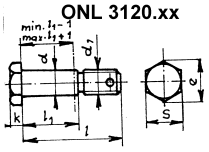
ONL 3147.24



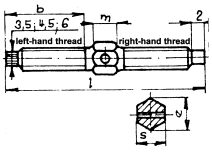
ONL 3148.X



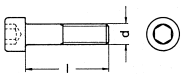
ONL 3120.xx



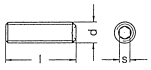
ONL 3444



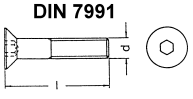
DIN 912 A2



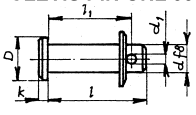
DIN 916



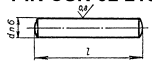
DIN 7991



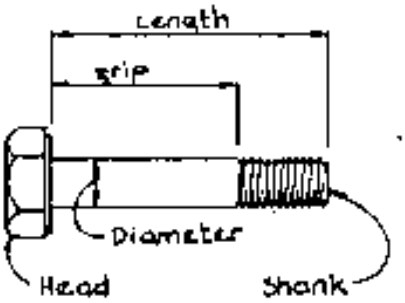
CLEVIS PIN ONL 3331.x



PIN ČSN 02 2150



Explanation of symbols used in Figures:
k ..... bolt head height
l ..... length
d ..... thread diameter
b ..... thread length
e..... width across corners
s..... width across flats
D..... bolt head diameter



Example of Bolt (screw) marking:
Screw M6x14..... Metric thread 6 mm
..... length 14

Abbreviations of Standards
ČSN Czech National Standard
DIN Deutsche Industry Norm
ONL Czech Aircraft Industry Standard

Supplementary digit meaning
The First supplementary digit following number of the Standard, indicates material, or tensile properties (symbols 5S, 8E, 10G and so on), or class of strength. Supplementary digits meaning bolts see in the following table.

First supplementary digit following Standard number	Mark		Tensile properties				Source material
	ČSN	ISO	R_m MPa	R_p 0.2 MPA minimum	KCU $J.cm^{-2}$ minimum	A5 % minimum	
.0	4D	4.6	333-539	206	-	25	11 434
.2	5S	5.8	490-686	392	-	10	11 109
.3	6G		680-780				
.4	8E	-	784-932	637	80	15	14 240 L-AUTO R
.5	8G	8.8	784-980	627	-	12	13 240
.6	10G	-	1000-1275	883	50	10	14 338 L-ROL
.7	10K	10.9	980-1177	883	-	9	14 240 15 230
.8	Brass						

The second supplementary digit following number of the Standard, indicates surface protection – refer to the following table:

.x0	no surface protection
.x2	chemical blacking
.x4	cadmium plating
.x5	zinc coating
.x7	nickel coating

3.2.2.3 Nuts

Most of the nuts used in the EUROSTAR kit are of the self-locking variety, which uses a nylon insert as a means of safetying the nuts. These can be used in any low-temperature application where there is no rotation in the components being fastened, which might tend to loosen the nut. In general, self-locking nuts used in high-temperature applications (such as in the engine compartment) are an all metal type.

Nutplates (also called “anchor nuts”) are used in numerous places in the EUROSTAR in inaccessible areas where a Standard nut cannot be used. Nutplate installation procedure see in 3.4.6.

Also the rivet nuts are used e.g. to attach the wing root fairing to the wing skin. See 3.4.7 for rivet nut installation.

Other nuts used in the EUROSTAR (primarily on the control system components) are castle nuts for use with drilled-shank bolts and cotter pins.

Refer to the last Section “APPENDICES” for detailed list of nuts supplied in the EV-97 EUROSTAR MODEL 2000 VERSION R kit.

Follow the instructions in this manual and in drawings and use a proper nut for a threaded joint. A small plastic bag with all the necessary fasteners (including nuts) is inserted into each sub-assembly bag.

The nuts supplied in the kit of EV-97 EUROSTAR MODEL 2000 VERSION R airplane are shown on the Figures below, the explanation of symbols and supplementary digit meaning follows the figures.

Explanation of basic symbols used in Figures:
e width across corners
s width across flats
m nut height

Supplementary digit meaning

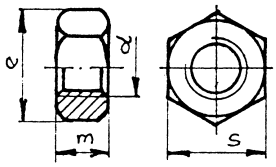
The First supplementary digit following number of the Standard, indicates material, or tensile properties (symbols 5S, 8E, 10G and so on), or class of strength. Supplementary digits meaning bolts see in the following table (the table is a selection of the ČSN 02 1005 and 02 1010).

First supplementary digit following Standard number	Class of strength		Trial tension MPa	Harndness HB	Source material	Tensile properties of associated obolts
.0	Nut with high 0.6h		400	302	11 434	4D
.2			500	302	11 109	5S
.4			800	302	14 240 L-AUTO R	8E
.6			1000	353	14 338 L-ROL	10G
.8					Brass	

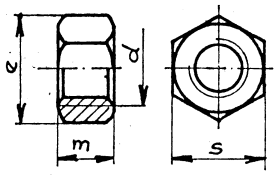
The second supplementary digit following number of the Standard, indicates surface protection – refer to the following table:

.x0	no surface protection
.x4	cadmium plating
.x5	zinc coating
.x7	nickel coating

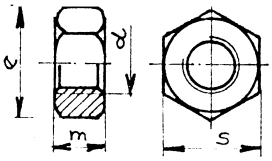
ČSN 02 1401.xx



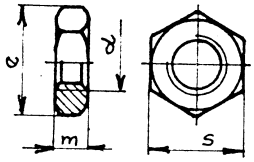
ČSN 02 1402.xx



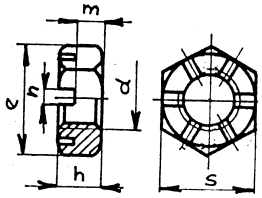
ČSN 02 1401.xx



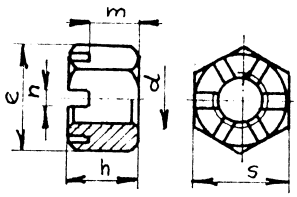
ČSN 02 1403.xx



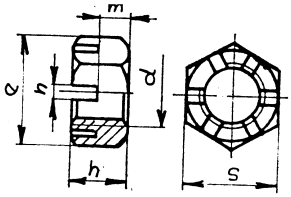
ČSN 02 1412.xx



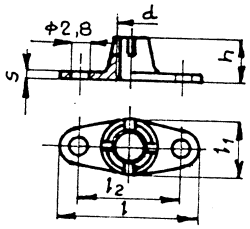
ČSN 02 1411.xx



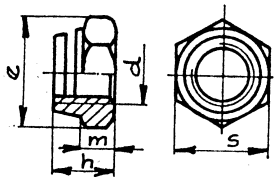
ČSN 02 1413.xx



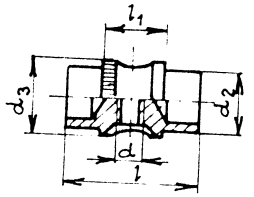
ONL 3243



ONL 3247

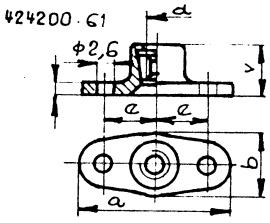


ONL 3446.x

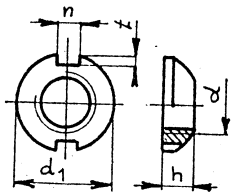


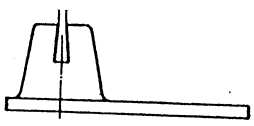
LDN 3244

424200.61

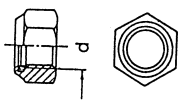


LDN 3233





DIN 980



3.2.2.4 Washers

Most of the washers supplied with the EV-97 EUROSTAR MODEL 2000 VERSION R kit are plain washers for use under hex nuts to provide a smooth bearing surface and to act as shims for obtaining the correct grip length of a nut and bolt assembly.

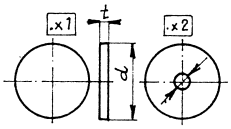
The lock washers are used for joints to be secured against release (e.g. control rods).

Washers are designated to the diameter of the bolt shank they fit.

Refer to the last Section "APPENDICES" for detailed list of washers supplied in the EV-97 EUROSTAR MODEL 2000 VERSION R kit.

Follow the instructions in this manual and in drawings and use a proper washer for a bolt shank. A small plastic bag with all the necessary fasteners (including washers) is inserted into each sub-assembly bag.

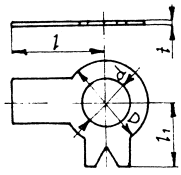
Washer d×t LDN3281.××



Tensile properties		
.1×	11373	pickled
.2×	L-ROL	sheet
.3×	15231.3	L-CM2

Surface protection	
.x1	washer without hole
.x2	washer with hole

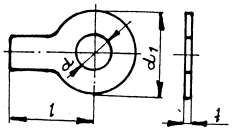
Washer d ONL 3288.x



Tensile properties		
.1	11320.31	cadmium plating
.2	L-AKVS	corrosion resist.

Surface protection

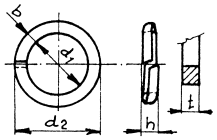
Washer d ČSN021751.××



Tensile properties	
.0×	11320.3
.5×	Brass

Surface protection	
.x0	No surface protection
.x4	cadmium plating
.x5	zinc coating
.x7	nickel coating

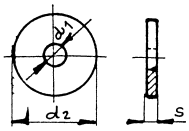
Washer d ČSN 021740.××



Tensile properties	
.0×	12061
.1×	14 260

Surface protection	
.x0	No surface protection
.x4	cadmium plating
.x5	zinc coating
.x7	nickel coating

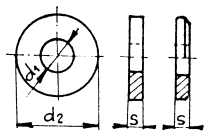
Washer d_1 CSN021726.××



Tensile properties		
.1×	15130	
.2×	424005.31	Aluminum
.3×	mäď	
.7×		Pressboard
.8×		Hardened paper

Surface protection	
.x0	No surface protection
.x4	cadmium plating
.x5	zinc coating
.x7	nickel coating

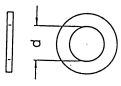
Washer d_1 ČSN 021702.××



Tensile properties		
.1×	11423	min.392 MPa
.2×	424201.6	Duralumin
.3×	423005.2?	Brass
.7×	ČSN503171.1	Paperboard
.8×	ČSN6441	11.2 Hard. paper

Surface protection	
.x0	No surface protection
.x4	cadmium plating
.x5	zinc coating
.x7	nickel coating

DIN 125
Stahl



3.2.2.5 Installation Practices

3.2.2.5.1 Bolts

When installing bolts, install them in such a manner that if the nut or fastener loosens or falls off, forces acting on the bolt such as gravity, air or wind loads and other obstacles such as grass will tend to keep the bolt in place. Thus, always try to install bolts from the top down and from the front towards the back.

When selecting a bolt, the grip length, that is the unthreaded portion of the shank, should be approximately equal to the thickness of the materials to be joined, plus washers spacers etc. No more than full thread should be below the surface of the materilas to be joined.

3.2.2.5.2 Washers

Washers should be used under both the head of the bolt and under the nut. They prevent having threads within the structure and prevent the nut from bottoming out. They help distribute the load and assist in lining up the locking hole when torqueing castellated nuts.

Should a bolt require any more than 2 regular thickness washers under the nut, you should consider going to the next smaller length bolt.

On aluminum alloy structure, use aluminum alloy washers under both the head of the bolt and the nut unless their omission is specified. By observing this practice, any corrosion due to the contact of the dissimilar metals will attack the washer rather than the structure. Use steel washers when joining steel structure with steel bolts.

3.2.2.5.3 Nuts

When installing nuts at least 1 1/2 threads should be visible when the nut is torqued correctly. If more than 4-5 threads show you should consider going to the next shorter bolt. Should less than 1 1/2 threads be showing you must either use a larger bolt or use the thinner washers. This is to ensure positive locking

It is recommended that self locking nuts be replaced after each use.

Always tighten nuts by holding the bolt and turning the nut. This prevents possible damage to the structure and galling and scratching of the bolt. A damaged bolt could have stress points and corrosion problems if the cadmium-plating is scratched off. Bear in mind that the bolt shanks will be hidden and any problems may not be immediately obvious.

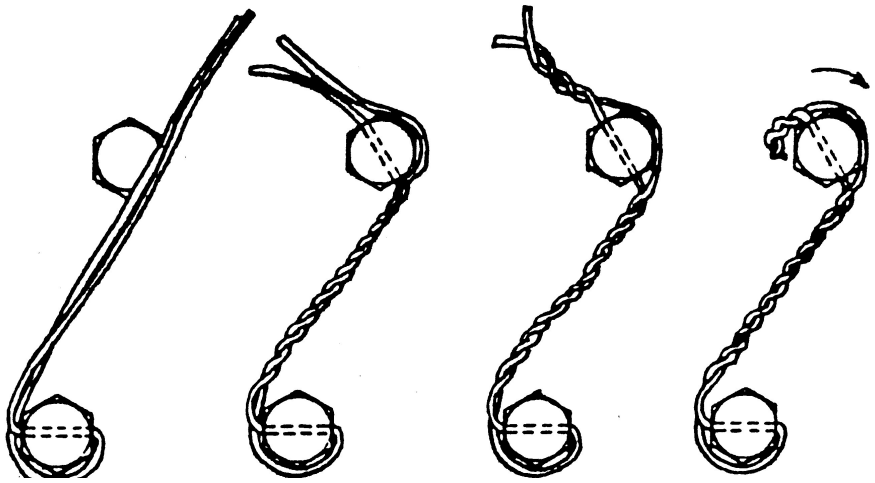
Always torque nuts. Use clean, dry hardware (no lubricants) torque the nut while holding the bolt.

Use good quality multi-hex sockets and wrenches if available. They ensure accurate control and feel with minimum damage to the fastener. Avoid adjustable wrenches, the possibility of damage to the structure and fasteners is too great, should the operator slip or the jaws of the tool move.

3.2.2.5.4 Safetying

All hardware and fasteners on your aircraft should be safetied to prevent loosening; backing out or possibly even falling out with the obvious catastrophic results.
In aviation safetying is achieved by wiring, pinning or clipping to positively lock a nut or bolt to prevent it loosening.
Torque is an important factor, however since it is not always possible to achieve the the desired torque on a material, safetying becomes doubly important.
Critical Nut and Bolt combinations should be safetying by using a castle nut, a bolt with a drilled shank and a cotter pin or wiring as in the diagrams below. This method should be considered mandatory combinations subject to rotation.

Fig. Safetying critical Bolt and Nut joint



3.2.2.6 Torque Moments

Since all the fasteners supplied in the EV-97 EUROSTAR MODEL 2000 VERSION R kit are in Metric system, the maximum torque moments shown in the table below are in metric system, also.

Adhere to the following rules:

1. If not specified do not lubricate neither bolt or nut
2. If possible, always torque nuts. If impossible and bolt head is torqued, use the highest value if torque moment range is specified.
3. Maximum torque moments use only for those materials and surfaces with enough thickness, area and strength resistant against cracking, deformation or other damage. Do not exceed the maximum torque moments.

		Strength class									
Metric thread		**4D**	**5D**	**4S**	**6E**	**5S**	**5R**	**6S**	**8G**	**10K**	**12K**
M4	N.m					1.67					
	kg.m					0.17					
M5	N.m					3.45					
	kg.m					0.35					
M6	N.m	4.31	4.90	5.39	5.88	6.86	7.84	8.33	9.80	13.72	16.67
	kg.m	0.44	0.50	0.55	0.60	0.70	0.80	0.85	1.00	1.40	1.70
M7	N.m	5.88	7.84	8.82	9.80	10.78	11.76	12.74	14.70	20.59	25.49
	kg.m	0.60	0.30	0.90	1.00	1.10	1.20	1.30	1.50	2.10	2.60
M8	N.m	8.33	10.78	12.74	13.72	15.69	17.65	19.61	22.55	32.36	38.24
	kg.m	0.85	1.10	1.30	1.40	1.60	1.80	2.00	2.30	3.30	3.90
M10	N.m	16.18	21.57	24.51	27.45	31.38	34.32	37.26	44.12	61.78	73.54
	kg.m	1.65	2.20	2.50	2.80	3.20	3.50	3.80	4.50	6.30	7.50
M12	N.m	27.45	36.28	42.16	47.07	52.95	58.83	63.74	74.53	104.93	125.52
	kg.m	2.80	3.70	4.30	4.80	5.40	6.00	6.50	7.60	10.70	12.80
M14	N.m	43.14	58.83	66.68	73.54	78.54	93.16	98.06	117.67	164.75	196.13
	kg.m	4.4	6.00	6.80	7.50	8.00	9.50	10.00	12.00	16.80	20.00
M16	N.m	60.80	78.45	93.16	98.06	107.87	127.48	131.29	164.75	225.55	274.58
	kg.m	6.20	8.00	9.50	10.00	11.50	13.00	14.00	16.80	23.00	28.00
M18	N.m	88.25	117.67	137.29	156.90	171.61	196.13	205.93	245.16	343.23	411.87
	kg.m	9.00	12.0	14.00	16.00	17.50	20.00	21.00	25.00	35.00	42.00
M20	N.m	117.67	156.90	176.51	196.13	225.55	245.16	274.58	313.81	441.29	539.36
	kg.m	12.00	16.00	18.00	20.00	23.00	25.00	28.00	32.00	45.00	55.00
M22	N.m	147.09	196.13	225.55	245.16	284.39	313.81	333.42	392.26	558.97	676.65
	kg.m	15.00	20.00	23.00	25.00	29.00	32.00	34.00	40.00	57.00	69.00
M24	N.m	205.93	274.58	313.81	353.03	392.26	441.29	470.71	549.17	755.11	970.85
	kg.m	21.00	28.00	32.00	36.00	40.00	45.00	48.00	56.00	77.00	99.00
Ultimate strength		37	50	37	-	50	-	60	80	100	120
ϑ in %		25	22	14	-	7	-	8	12	8	8
Yield point		21	28	32	36	40	45	48	64	90	108

Torque moment formula (valid for all bolt size):

$$M_{kmax} = 1{,}065 \times \frac{d \cdot \sigma \cdot \cdot S}{m}$$

Legend:

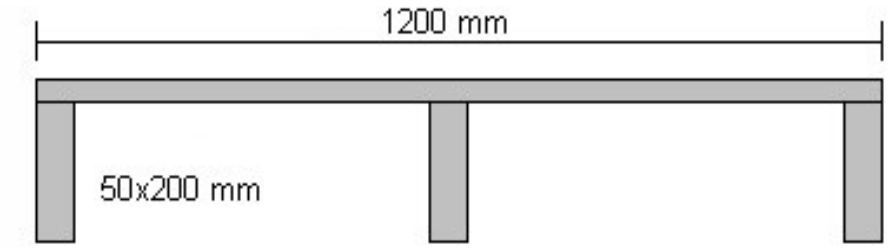
Mk	torque moment	kg.cm
d	bolt shank diam.	Centimeter [cm]
σ	min.yield point	kg/cm^2
m	safety factor	(m=1,25 for σ<50 kg/mm^2; m=1,43 for σ>50 kg/mm^2)
s	lead of helix	cm

3.3 Workshop Equipment, Required Tools and Instruments

3.3.1 Workshop

3.3.1.1 Workspace

Smaller sub-assemblies can be assembled on a common worktable.
Larger sub-assemblies, e.g. wing flap require more workspace – you will need a strong level workbench, with work space around the table. A basement or single car garage will provide plenty of room for most assemblies.
Prepare the workshop before you get started, and clear away other clutter from your workspace. Since the airplane has all metal construction and not the laminated one – you do not need a temperature controlled or dust-free environment. Assembly of the kit is a fairly quiet process.
Recommended table size is 3000x1200mm (10x4 ft), that is a wing assembly requirement, this table would fit in a single-car garage or basement workshop. You can easily build a workbench with particle board or plywood of 20 mm (3/4 in) thickness and support beams. Make sure that the workbench is sturdy and flat and level so that you can use it as a flat reference.



3.3.1.2 Safety Equipment

The below listed safety equipment is strongly recommended to ensure health safeguards:

- Hearing protectors. Strongly recommended when riveting with a rivet gun
- Safety goggles or eye shield. Eye protection is needed when grinding metal on a bench grinder, when using a die grinder and when handling some chemicals
- Particle masks for protection from dust generated by sanding or grinding
- Paint spray respirator mask for protection from chemical vapors and solvent fumes

Also the following is recommended:

- Fire extinguisher (and to be familiar with its use)
- Ventilation fan

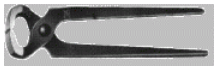
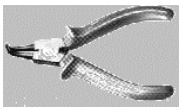
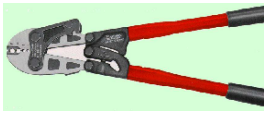
3.3.2 Tools and Instruments

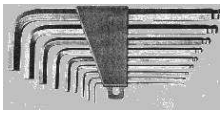
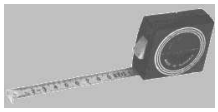
Tools and instruments required to build your EV-97 EUROSTAR MODEL 2000 VERSION R are shown in the table below.
This tool list is not meant to be exhaustive; as you work on your EUROSTAR, you will undoubtedly think of other useful tools to procure. You may already have some favorite tools not listed here that you find indispensable.
Brief descriptions of the less common or less familiar tools needed to assemble the EUROSTAR are provided here; for more detailed descriptions of the tools and their proper use, refer to the 3.4 Techniques, which follow the tool list.

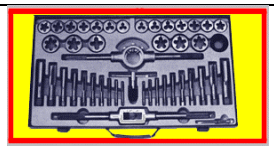
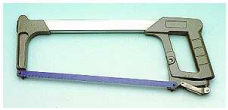
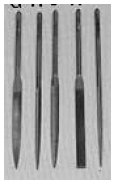
NOTE
For builders in countries that do not use the metric system, we recommend procuring a set of metric-system tools (tapes , rules, drill bits etc.) and becoming familiar with their use rather than converting from metric to English measurements. We feel that it is better to maintain consistency and use the metric system throughout because converting between systems is an unnecessary, time-consuming step that introduces one more opportunity for errors to occur.

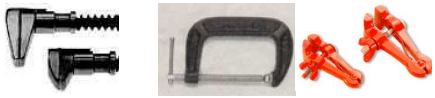
3.3.2.1 Required Tools and Instruments

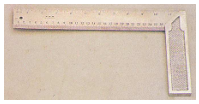
No.	Tool	Pcs. Req.	Remarks
1.	Clecos diam. 2.4 mm	60	These fasteners allow you to temporarily hold your sheet metal together without having to rivet. After drilling a hole, you insert Cleco with the pliers, and it holds the material together firmly while you drill out more holes. Taking them out is as easy as putting them in. Generally, Clecos are only available through aircraft tool supply shops.
2.	Clecos diam. 3.2 mm	30	
3.	Clecos diam. 4 mm	10	
4.	Binding wire	As needed	Binding wire is needed to safety critical nut and bolt combinations, temporary bind cable ens prior to pressing etc.
5.	Center punch	1	To clinch aileron (flap) hinge wire end
6.	Rivets sets	Set	Rivet sets are needed during driving “Standard” rivets. Which rivet sets to use depends on a method of driving – hand driving, pneumatic driving or squeeze riveting. Refer to the APPENDICES for rivets supplied in the kit In the kit are supplied.
7.	Calliper	1	A caliper helps you to find a hole center on sheets beeing drilled and riveted together.
8.	Scantling	1	Helps you to position wing
9.	Scriber	1	For marking
10.	Centering pin diam. 3.8 mm	1	Use a steel rod of suitable daimeter to made the centering pins. Sharpen one end of that rod.
11.	Centering pin diam. 5.8 mm	1	

No.	Tool	Pcs. Req.	Remarks
12.	Aluminum tip hammer 200 gr (0.5 lbs) 	1	Aluminum tip hammer is preferable for duralumin sheets, using a locksmith´s hammer may cause deformation of parts
13.	Locksmith´s hammer 	1	Middle size is recommended. Hammeris needed to drive wing suspension pins etc..
14.	Combination pliers 	1	You need the various pliers to assemble the kit.
15.	End cutter 	1	
16.	Alligator pliers 	1	
17.	Needle nose pliers 	1	
18.	Diagonal pliers 	1	
19.	Retaining ring pliers 	1	
20.	Cleco pliers 	1	Cleco pliers are required to put the Clecos in the sheets beeing riveted.
21.	Nicopress pliers 	1	Nicopress clamps are used for steerable nosewheel control cables. To press the clamp correctly you need this pliers.
22.	Hand riveter for blind rivets 	1	Most riveted joints are “Blind rivet joints”. To drive blind rivets you need this hand riveter with changeable Nose Bushing piece. If you have an air compresor, you may want to use a pneumatic rivet puller.
23.	Hand riveter for rivet nuts 	1	Required to install rivet nuts. Rivet nut installation procedure is described in.3.4.7.

No.	Tool	Pcs. Req.	Remarks
24.	Cable cutting snippers 	1	To cut the cables.
25.	Nut wrenches 	Set	Recommended is a set of metric nut wreches.
26.	Allen wrenches 	Set	Recommended is a set of metric allen wrenches.
27.	LOCTITE 243 		Loctite 243 is a threadlocking adhesive especially well suited for fasteners.
28.	Rubber adhesive	0.5 kg	Rubber adhesive is needed to stick the upholstery on interior fuselage side panels, and to stick rubber packings on the airframe.
29.	Magnet	1	A Magnet helps yout to draw the nosewheel leg attachmment screws out of the leg upper tube.
30.	Grease Castrol, Mobil etc.	1	Most movable joints should be geased.
31.	Tape rule 	1	2 meters tape rule is suitable.
32.	Flexible snake drill 	1	Makes easy drilling in poorly accessible places.
33.	Pocket knife 	1	General purpose pocket knife is suitable.
34.	Hand shears 	1	To shear an upholstery etc.
35.	Metal sheet snips 	1	Recommended are snips for left-hand cuts and right-hand cuts. Both will also make straight cuts.

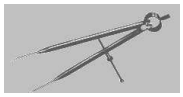
No.	Tool	Pcs. Req.	Remarks
36.	Die M4 and M5 + die stock wrench 	1	To thread a gus strut end beeing cut. Recommended is a set of taps and dies.
37.	Plumb bob 	1	Makes easy the measurement of landing gear arms to the wing leading edge during weighing procedure and Center of gravity calculation.
38.	Soldering iron + tin 	1	Necessary to connect contacts of airplane electrical systém.
39.	Soldering gun 	1	Soldering gun is to solder up the cable ends and thus avoid fraying.
40.	Wrapping paper		To protect the plexiglass when painting the canopy frame.
41.	Sand paper 	Various	Sand paper you need to grind the laminated part edges and thus make easy the positioning of those parts on the airframe. Therefore you need sand papers of various coarseness and some blocks to attach the sand paper. Using a grinding machine is sure advantageous.
42.	Paper tape 		Paper tape attch the wrapping paper edges to the canopy prior to canopy painting.
43.	Hand metal saw 	1	General hand saw may be also used to cut plexiglass.
44.	Files 	Set	Recommended is a set of middle or smaller size files of various sections (flat, round, square etc.). Also swiss needle files are recommended. Files may be used to deburr chips on edges.
45.	Cone shaped rotary file 	1	To round a venting hole in the plexiglass canopy.

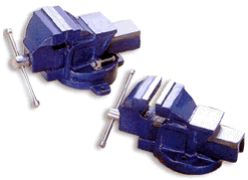
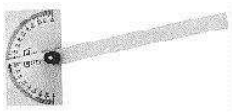
No.	Tool	Pcs. Req.	Remarks
46.	Emfimastic hand gun 	1	The Emfimastic sealant must be applied on the sheets beeing riveted with blind rivets. The tube with sealant is inserted in the gun.
47.	Heat gun 	1	May be used to force glued joint hardening and to heat shrinking hoses on some contacts.
48.	Cushions under the fuselage	3	Should be inserted under the fuselage being supported to prevent skin deformation.
49.	Airplane supports	3	Recommended are four-legged steel supports.
50.	Tightening rubber straps	2	Tightening rubber straps are needed to tighten the wing skin to the ribs. A rubber strap of 3 meters (10 ft) is suitable.
51.	Rule 300 mm 	1	Steel rule is preferable.
52.	Jig to position stabilizer skin	1	This jig is described in the text.
53.	Jig to position the ribs on the spar when being drilled	1	This jig is described in the text.
54.	Jig to adjust root rib spacing	1	This jig is described in the text.
55.	Sand bags 	2	Sand bags are helpful to load the fuselage and thus avoid its pitching. Also used to load the aileron skin etc. Recommended weight is cca 5 kg (10 lbs).
56.	Rasps 	Set	The rasps of various sections help you to rasp the edges of laminated parts.
57.	Workbench	1	See 3.3.1.1 for more details
58.	Clamps 	Set	Keep at disposition C-clamps, side grip clamps etc. Clamps are required to clamp some sheets beiing drilled.
59.	Phillips tip screw driver 	Set	A set of various screw drivers is recommended.
60.	Flat tip screw driver 	Set	
61.	Tube (steel, duralumin, brass) length 334.5 mm (13.17 in) diam. 6-8 mm (1/4"-1/3")		Slip the tubes and the stabilizer ribs over a bar to adjust rib spacing
62.	Soft pencil	1	To mark rib flanges centerlines etc..
63.	Bar (steel, aluminum, brass) length 1050 mm (3.44 ft), diam. 4 mm (1/6")	1	A jig to adjust stabilizer rib spacing

No.	Tool	Pcs. Req.	Remarks
64.	Try square 	1	To position correctly the wing ribs on the spar.
65.	Riveted sheets tightener	1	The tube to tighten sheets being riveted with standard rivets prior to the snap head forming.
66.	Electric hand drill 	1	You will need a standard "hardware store" electric hand drill. Preferably, use a high speed drill (2,500 rpm), which makes drilling quicker and easier. A variable speed drill is often easier to use. Place a Rubber washer at the drill bit shank – This way when you drill through a hole, the rubber washer will protect the material from being dented by the steel "chuck" of the drill.
67.	Drill bits 	Set	A set of metric drill bits is recommended. You will need a number of drill bits, especially the following diameters: 2.1/2.5/2.6/2.8/3.0/3.1/3.3/4.0/4.1/4.5/5.2 /5.8/8.0/10.0 mm. Sharpening of blunt drill bits is not recommended, always use a new, sharp drill bit.
68.	Extendrill diam. 2.5 mm	1	This drill bit has extended shank.
69.	Reamers 	1	To ream a holes at exact diameter. The following reamers are required: 6H7 / 7H8 / 8H8
70.	Gasket puncher diam. 8 mm (1/3")	1	To punch a hole through the rubber packing. The puncher may be made from a steel tube of 8 mm (1/3") internal diameter by sharpening edges on either end of tube. Position the sharpened tube end on the gasket and hammer at the opposite end to punch a hole through the packing.
71.	Countersinking bit 90x12	1	To countersink a hole for countersunk-head rivet.
72.	Permanent markers	Set	Recommended are fin tip markers.

3.3.2.2 Recommended Tools and Instruments

The tools and instruments shown in the table below are not necessarily required to assemble your kit but some procedures (e.g. airplane final assembly) may be done easily by using them. You may also use your favorite tools not listed here.

No.	Tool	Pieces	Remarks
1.	Tire inflator	1	To pump the wheel tires.
2.	Angle grinder 	1	Quicken laminated part edges grinding.
3.	Cutters of various shapes	Set	To cut holes in the sheets and trim sheet edges etc.
4.	Torque wrench 	1	To torque bolted joints with a proper moment.
5.	Socket wrenches 	Set	Quicken and make easy tightening of bolted joints.
6.	Flank drive offset box Wrenches 	Set	Make easy tightening in places accessible with dificulty whenever using of nut wrenches is complicated..
7.	Tire gauge	1	To measure tire correct pressure.
8.	Calliper 	1	Calliper is intended for fine measurement e.g. to measure a bolt diameter.
9.	Leveling instrument + equipment	1	Intended for airplane fine leveling.
10.	Spring bow divider 	1	Advantageous for marking of rivet spacing on sheets.
11.	Pneumatic riveting kit 	1	Also a pneumatic rivet puller for blind rivets is helpful because most rivet joints are driven with blind rivets.

No.	Tool	Pieces	Remarks
12.	Paint spraying gun + air compressor 	1	If you decide to paint your airplane yourselves.
13.	Bench vise 	1	The duraluminum parts should not be clamped with vice steel jaws – either replace steel jaws with duraluminum ones or put a bent duraluminum sheet on both jaws.
14.	Deburring tools 	Set	Advantageous for holes and edges deburring.
15.	Protractor with adjustable arm 	1	For control surface deflections measurement.
16.	Water level 	1	To level the airplane prior the weighing.
17.	V-A meter	1	To measure current and voltage of airplane electrical system.

3.3.3 Sources for Tools

Most required tools are general purpose tools and may be available at your local hardware store but some required tools and instruments (e.g. Clecos) will be probably unavailable. For those tools, contact the suppliers listed in the table below to order catalogs.

Aircraft Spruce and Specialty Box 424 Fullerton, CA 92632 (800) 824-1930 Fax: (714) 871-7289	Aircraft Tool Supply Company P.O.Box 370 Oscoda, MI 48750 (800) 248-0638 Fax: (517) 739-1448
U.S. Industrial Tool ans Supply 15101 Cleat St. Plymouth, MI 48170 (800) 521-7394/4800 Fax: (313) 455-3256	Cleveland Aircraft Tool and Material 1804 First St. Boone, IA 50036-4417 (515) 432-6794 Fax: (515) 432-7804
Wicks Aircraft Supply 410 Pine St. Highland, IL 62249 (800) 221 -9425 Fax: (618) 654-6253	Avery Enterprises, Inc. P.O. Box 387 Bedford, TX 76095 (817) 267-9407 Fax (817) 545-2829

3.4 Techniques

3.4.1 Useful Things to Know

3.4.1.1 General Advice

Following are a few useful general building tips that will make your project a success:

- Be consistent on the project and plan a working schedule. It´s much more efficient to wrok on the project consistently. Plan a work schedule, and follow it.
- Use the help of your friends, but remember that you are in charge, and inspect their workmanship.
- Follow the instructions and contact the kit manufacturer if you are in doubt
- Take experience of other builders
- Take your time, proceed at a steady and comfortable pace, and be sure that you understand the figures, drawings, and instructions before you work the parts (thus avoiding mistakes). Do not hesitate to cross-reference or make notes, but don´t spend unnecessary time reading or re-measuring, etc. , and avoid the tendency to be excessively perfectionist.
- Overcome the initial fear that you´ve undertaken a complex that´s too demanding. Have confidence in yourself :You can do it, but don´t become over confident which may lead to errors.
- Avoid distractions and focus on the project at hand.
- If you don´t understand something, contact us for guidance (refer to the 2.6 Customer Support).
- Have the proper tools and workshop, and use the tools correctly and efficiently.

3.4.1.2 Additional Notes

Join the Experimental Aircraft Association (EAA) and also join a local EAA Chapter to meet with other builders. Local builders can provide you with help (and lend tools, as well!). EAA also has a Technical Counselor Program, which provides local technical help and guidance at no charge. Other programs / member benefits include the Flight Advisor Program, Aircraft Finance Plan, Aircraft Insurance Plan, and more. The Technical Counselor and Flight Advisor programs are highly recommended. To join EAA, call 1-800-322-2412. If you are not the US builder than contact your national aviation organization (the EV-97 EUROSTAR MODEL 2000 VERSION Rcomes under “ULTRALIGHT” category in most European countries).

3.4.1.3 Recommended Reading

Many of the building / maintenance procedures for EV-97 EUROSTAR MODEL 2000 VERSION Rkits are standard aircraft procedures. A good reference book for metal construction is the “Standard Aircraft Handbook” by Larry Reithmaier (Aero Publishing), and/or the “Standard Aviation Maintenance Handbook” (ISBN 0-89100-282-0) Refer to the 2.7 more for publications.

3.4.2 Sheet Metal Cutting

Some sheet-metal parts need trimming, which is easily done with hand snips. Cutting is made easier by holding the snips at a slight angle to the material, and not closing the snips completely (only 1/2 to 3/4 of the scissor blade length). When cutting away a larger section, it´s often easier to first make a rough cut (about 10 mm, 1/2" from final cut), and then making the final cut. The cut edge may be filed for smoothness, if required..

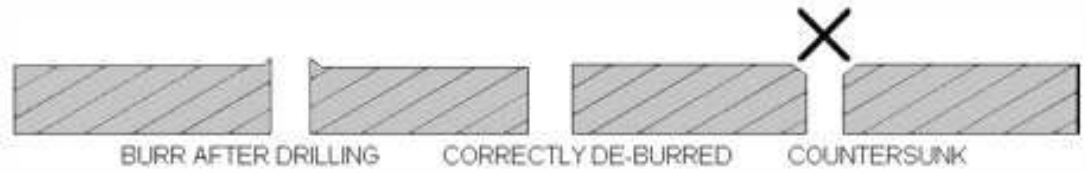
3.4.3 Deburring and Filing

Parts often need to be de-burred after having been drilled or cut. Any burrs between two surfaces or along edges must be removed. The easiest way to remove a burr from a drilled hole is to use a large drill bit, and to turn it by hand a few times in the smaller hole so that it removes the burr.

NOTE

Make sure that only the burr is removed, and that you do not enlarge or "countersink" the hole Do not use a power drill for this.

You can also lightly pass over the holes with a flat file to remove the burrs (be careful not to scratch the material).



For sheet metal edges, use a smooth file, running it lightly along the edge at an angle. Run your hand lightly along edges and over drilled holes to feel for burrs. Sharp edges may be very lightly filed to avoid cuts. For filing away larger sections, you can first use a coarser double-cut file. For final filing, use a smooth file and make sure that files section does not become "corrugated" from filing. Tool supply shops also have specialized de-burring tools available (for drilled holes and sheet metal edges). These are not required, but you may find them useful.

3.4.4 EMFIMASTIC Sealant Application before Riveting

All the blind rivet joints must be sealed with Emfimastic PU 50 sealant or equivalent prior to driving rivets.

Refer to the APPENDICES of this Assembly manual for more details and Technical data of One component Polyuretan-Based Sealants. If you are in doubt with EMFIMASTIC equivalent sealant, contact us to help you.

EMFIMASTIC PU can be applied by a pneumatic or hand gun (Kit required tool). After application the sealant can be finished by using a damp jointnain or knife. The surface must be dry, clean, free of dust and oil. Material should be applied at temperatures between +5 °C and +40 °C (41 °F and 104 °F). In the case of an application at temperature under – 10 °C (14 °F) , sealant should be stocked by +20 °C (68 °F).

Shelf life of Emfimastic is 9 month in unopened packing at temperatures between +5 °C and +25 °C (41 °C and 77 °F). To assemble the EV-97 EUROSTAR MODEL 2000 VERSION Rkit cca 5 tubes of sealant are needed.

3.4.5 Riveting

3.4.5.1 Summary of Riveting Procedures

The following list provides a general summary of the steps used to rivet together two sheet aluminum components:

1. Straighten and deburr the parts, as necessary.
2. Mark centerlines on rib and spar flanges.
3. Align the parts and clamp them together.
4. Drill the rivet holes to size, installing Clecos as you go.
5. Disassemble the parts, deburr the rivet holes and remove drill chips and shavings.
6. Corrosion-proof parts that will be inaccessible after assembly.
7. Apply EMFIMASTIC PU 50 or equivalent sealant on either part being riveted.
8. Reassemble and clamp the parts together with Clecos
9. Rivet the parts together.
10. Inspect your work and replace defective rivets, if necessary.

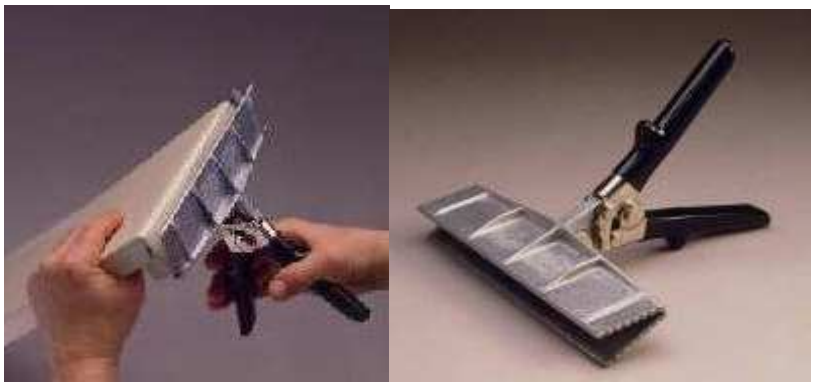
The rest of this section describes these procedures in detail.

3.4.5.2 Straightening and Deburring Parts

Most of the components of the EUROSTAR airframe are supplied in a fully formed condition ready for assembly. Some parts may require some minor adjustments and clean-up, however. Taking the time at this stage to accomplish minor adjustments will simplify assembly as work progresses.

3.4.5.2.1 Straightening

Use a try square to check the flanges of ribs for squareness to the webs. If the flanges are not quite square, use duck bill pliers (with the jaws taped to prevent damage to the flanges) to gently increase or decrease the angles of the flanges. It doesn't take much to accomplish this, so be careful and check your work frequently as you go.



NOTE

Some of the flanged parts in the EUROSTAR kit do not have their flanges perpendicular to their webs. The flanges on the rudder ribs, for example, must match the taper of the rudder, so you shouldn't expect them to be square.

3.4.5.2.2 Deburring

Use a deburring tool (recommended) or small, fine-toothed files to remove any burrs remaining on the parts from the manufacturing process. Use flat files on straight or convex edges; use half-round or round files on concave edges, such as the perimeters of lightening holes. Deburring the parts will make them more comfortable to handle, as well as eliminating stress risers which might lead to cracking from metal fatigue. Don't go overboard with this; a few strokes with a file or one pass with the deburring tool is all you need. This is where the advantages of the deburring tool become obvious; filing parts can be tedious.

3.4.5.3 Marking Rivet Lines on Riveted Parts

Before beginning to assemble the structural framework of major assemblies, rivet lines must be marked on rib and spar flanges. When the skins are positioned on the framework in preparation for drilling the rivet holes, these marked lines will be visible through the pre-punched pilot holes in the skins and can be used as guides to align the skins on the underlying framework. Such lines are usually centered on the rib or spar flange and are thus most often called "centerlines" in later sections of the Manual; however, in a few places the lines must be drawn slightly off-center at a specified distance from the flange edge.

Use a fine-point felt tip marker to mark the lines. It's not necessary to take great pains to measure the exact centerline of the flange and then use a straightedge for marking. You can just "eyeball" the location of the centerline and mark it freehand. To do this, hold the pen as you normally would between your thumb and forefinger. Place the point of the pen on the centerline at the far end of the flange while resting your middle, ring and little finger tips against the edge of the flange, as shown in the accompanying photograph. Hold your hand in this position and draw the pen toward you along the flange; your fingers sliding along the edge of the flange keep the pen point on the flange centerline as you mark the line.

You can also use a marking pen mounted in a compass (the kind for drawing circles, not the magnetic kind!). Set the distance between the legs of the compass equal to the distance from the edge to the center of the flange. Slide the leg with the point along the edge of the flange while marking the centerline with the pen; the compass keeps the pen on the flange centerline while marking.

3.4.5.4 Clamping Parts Beeing Riveted

It is very important to hold sheet aluminum parts together tightly during the riveting process. If the parts are not held tightly together, the rivet will tend to expand between the parts, leaving a gap that reduces the strength of the riveted joint. The usual method of clamping sheet metal parts in which holes have already been drilled is to use sheet holders, or "Clecos." If holes are not available in the parts being joined, use small C-clamps or spring-loaded, side-grip clamps (Cleco clamps) to hold the parts together while riveting.

Fig. Parts clamped with Clecos

A Cleco consists of a small, cylindrical steel body which contains a plunger, a coil spring, a pair of locking wires and a spreader. When the plunger is depressed with a pair of Cleco pliers, the locking wires extend beyond the spreader, reducing the distance between the wires, which reduces the combined diameter of the two wires. The Cleco can then be inserted into the rivet hole. When the pliers are released, the spring pulls the locking wires back over the spreader, which expands the combined diameter of the locking wires to the diameter of the rivet hole. The Cleco's internal spring holds the parts tightly together by compressing them between the body of the Cleco and the hooks on the locking wires. Removing a Cleco is accomplished by reversing the installation process.

CAUTION

To avoid enlarging the rivet hole, be careful to compress the Cleco fully so that the diameter of the locking wires is reduced to a minimum. Also, refrain from twisting the pliers to install and remove the Cleco; twisting can deform the hole.

Cleco fasteners are available in all common rivet sizes and are color-coded according to the following table:

Fastener Size:	Cleco Color Code	Drill Size:
3/32" (2.4 mm)	Silver	#40
1/8" (3.2 mm)	Copper	#30
5/32" (4.0 mm)	Black	#21
3/16" (4.8 mm)	Brass	#11

When clamping skins to a structural framework in preparation for drilling the rivet holes to their final size, the rib and spar flanges in the framework must be centered under the pilot holes in the skins, using the lines marked on the flanges as references for alignment. A handy tool for aligning the ribs is a "rib alignment probe," which you can make yourself. The probe is simply a length of aluminum or copper tubing with a small, 90° hook bent in one end (or you could use a wooden dowel with a hook screwed into the end). The probe can be inserted into the structure spanwise through the lightening holes in the ribs to push or pull the ribs into alignment, as necessary. The probe must be long enough to reach all the ribs in an assembly from a location that has not yet had the skins installed; usually about 1200-1500 mm (4-5') long is sufficient.

3.4.5.5 Drilling

Recommended drill sizes for rivets supplied in the EV-97 EUROSTAR MODEL 2000 VERSION Rkit are shown in the following table.

	Rivet Designation	Shank diameter	Recommended drill diameter [mm]
AVEX – Blind rivets	1604-0412	3.2	3.3-3.4
	1691-5307	3.0	3.1-3.3
	1691-0410	3.2	3.3-3.5
	1691-0414	3.2	3.3-3.5
	1691-0512	4.0	4.1-4.3
	1691-0516	4.0	4.1-4.3
	1691-0521	4.0	4.1-4.3
Standard rivets	-	2.6	2.7-2.8
	-	3.0	3.1-3.3
	-	3.5	3.6-3.7
	-	4.0	4.1-4.3

The aluminum skins supplied in the EV-97 EUROSTAR MODEL 2000 VERSION R kit have not pre-drilled pilot holes. When drilling holes through the skin that does not have an existing pilot hole for guidance, lightly center punch the locations for the rivet holes before beginning the actual drilling. The center punch mark acts as a guide and lets the drill bit grip or bite into the metal with greater ease. Make the center punch mark large enough to prevent the drill from slipping out of position, but punch lightly enough not to dent the surrounding material. To prevent deforming thin sheets when making a center punch mark, back up the material with a thick sheet of metal or a bucking bar.

In order to drill accurately-sized rivet holes, it is essential to use sharp drill bits. Worn bits not only tend to make enlarged, out-of-round holes, but also are more likely to "walk" across the surface being drilled. Either discard or sharpen worn drill bits. Also, before beginning to drill, always test the drill bit for trueness by running the drill freely and watching the end of the bit. If the bit wobbles, it may be because of burrs on its shank or because it is bent or incorrectly chucked. Do not use a drill bit that wobbles or is bent; such a bit causes enlarged holes. This cannot be over-emphasized: use straight, sharp drill bits; don't attempt to hand sharpen them.

When drilling, hold the drill motor firmly with both hands. Always hold the drill at right angles to the work, regardless of the position of the hole or the curvature of the surface. Extend the index and middle fingers of the left hand against the metal to act as a guide in starting a hole, and as a snubber or brake for when the drill goes through the material. You can also use special drill stops that fasten to the drill bit to limit the bit's penetration through the material. Another technique for starting a hole is to use a long drill bit and pinch the smooth shank of the bit between your fingers, initially, to act as a guide.

HINT

When drilling holes in sheet metal; you can position the drill bit at a right angle to the surface by aligning the bit with its own reflection in the material. Check from two different directions because this method cannot detect misalignments that are in the plane defined by the drill bit and your eye.

Use a right-angle drill or drill extensions and adapters when access is difficult with a straight drill. Never tip the drill sideways when drilling or when withdrawing the drill from the material because this causes elongation of the hole.

Fig. Holding hand drill correctly

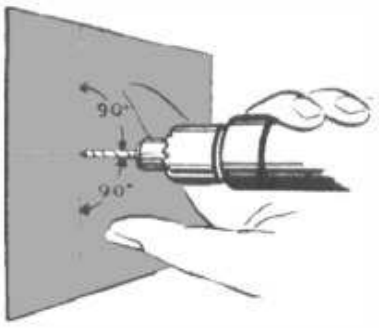
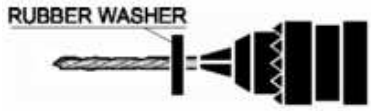


Fig. Rubber washer on the drill bit shank



3.4.5.5.1 Preparation for Drilling Rivet Holes

As mentioned previously the skins supplied in the EV-97 EUROSTAR MODEL 2000 VERSION R kit have not undersized pilot holes already punched in them. First you should mark centerlines on rib flanges and on the skins also. Then drill undersized pilot holes through the skin.

After the internal structural framework (the spars and ribs) has been assembled and jigged, the skins are positioned and clamped to the structure. Then the rivet holes in the skin are then used as guides to drill the rivet holes to the final size.

It is very important that the rivet holes be of the correct size and shape and free from burrs. If a hole is too small, the protective coating will be scratched from the rivet when the rivet is driven through the hole; if a hole is too large, the rivet will not fill the hole completely. When such a rivet is bucked, the joint will not develop its full strength and structural failure may occur at that spot.

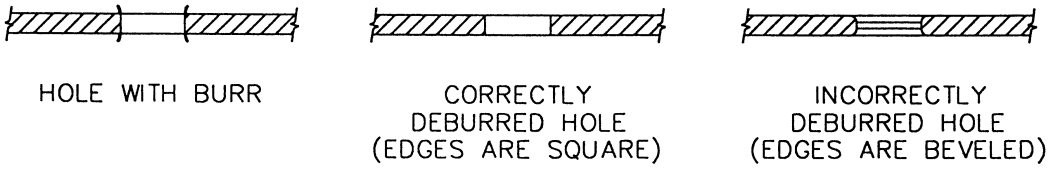
3.4.5.5.2 Drilling a Line of Rivet Holes

When drilling a line of rivet holes in an assembly, it's best to first drill holes at the ends of the line and at several places along the line, while making sure that the parts are held in correct alignment. Insert Clecos into each of these first holes after drilling to "tack" the parts together and maintain alignment between them. Then go back and drill the intervening holes. This practice will help prevent warped assemblies caused by slight misalignments.

3.4.5.6 Deburring

When holes are drilled through sheet metal, small burrs are formed around the edges of the hole. The holes must be deburred before riveting. This can be done by hand using a drill bit larger than the hole by placing the point of the larger bit into the hole and twisting the bit through several revolutions between your fingers. (If you use this method, wrap the drill bit with tape to protect your fingers.) You can also use a countersink bit in an electric drill, using very light pressure.

Fig. Deburring Rivet Holes



NOTE

Be careful just to remove the burr; do not enlarge the hole or bevel the edges of the hole. See Figure above.

The usual sequence is to drill all of the holes at once and then disassemble the parts so that both sides of all holes can be deburred..

NOTE

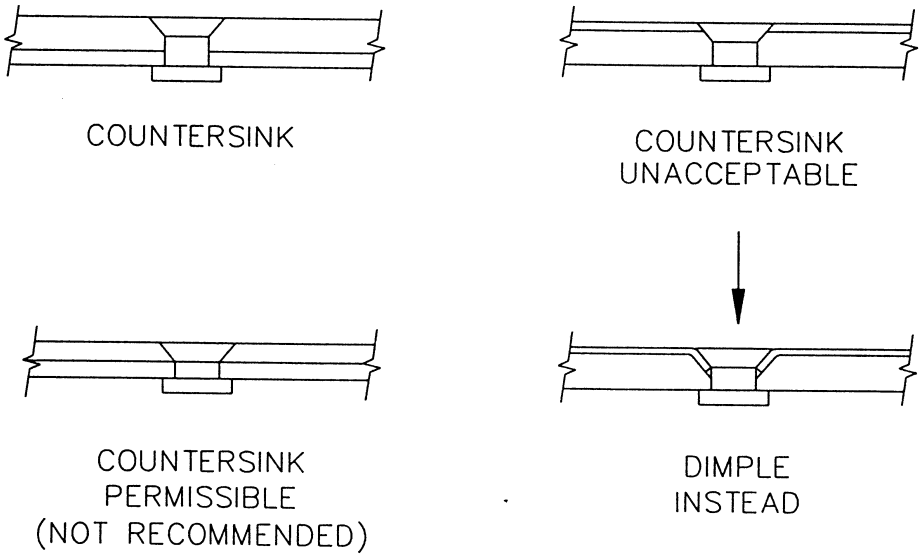
While the parts are disassembled, thoroughly clean away all chips that have accumulated between the parts. If drill chips or shavings prevent good contact between the parts, the rivet joint will not achieve its full strength.

Use an air nozzle or the exhaust from the air drill to blow the drilling chips off the surface; brushing the chips with your hand or a rag tends to scratch the aluminum cladding. A special tool, called a "chip chaser" (see 3.4.3), can be used to remove drill chips from between parts that can no longer be disassembled.

3.4.5.7 Countersinking and Dimpling

To use flush rivets in sheet-metal aircraft construction, the surface must be either countersunk or dimpled to accept the rivet head. The proper method for any particular application depends mostly on the thickness of the parts being riveted and the height of the rivet head. As a general rule, use the machine or drill countersink method when the thickness of the material is greater than the thickness of the rivet head; use the dimpling method on thinner material. Dimpling works best in material no more than 0.1 mm (.040") thick. Refer to the Figure and Table below..

Fig. Countersinking and Dimpling



Preffered Method	Rivet diam. 2.4 mm (3/32”)	Rivet diam. 3.2 mm (1/8”)
Dimple	Material 0.8 mm (.032”)	Material 1.0 mm (.040”)
Countersink	Material 1.0 mm (.040”)	Material 1.3 mm (.050”)

NOTE

Table shown above gives the preferred method for structural applications. For other applications, you have greater leeway in deciding between countersinking and dimpling. For instance, when using 2.4 mm (3/32") rivets to mount nutplates to 0.8 mm (.032") thick aluminum, it is normal and acceptable to countersink rather than to dimple the rivet holes.

Flush (countersunk) rivets are specified in only a few locations on the EUROSTAR – e.g. cockpit canopy.

3.4.5.7.1 Countersinking

To countersink sheet metal for flush head rivets, use the machine stop countersink tool which cuts away the edge of the rivet hole to form a recess -called the "well" or the "nest"- for the rivet head. The countersink tool's cutter has a pilot that fits into the drilled hole to accurately position the cutter. It also has an adjustable stop to help ensure that the depth of the countersink will be accurate. Adjust the stop to the proper depth by practicing with a rivet on a piece of scrap material. (The head of the rivet must not extend more than 0.006" either above or below the surface of the metal, in most cases. A barely visible ring of cut metal around the rivet head is just right.) You can use the sheet metal supplied in the sheet metal practice kit for adjusting the countersink depth. (If you are countersinking .032" material for installing nutplates, use a thicker sheet for practice to get a true indication of the countersink adjustment.)

To cut accurate countersinks, hold the countersink tool at right angles to the material. Do not tip it. Tipping elongates the well and prevents the rivet head from seating properly. Oversized rivet holes, undersized countersink pilots, chattering caused by improper use of the countersink or by a countersink in poor condition, and a countersink not running true in the chuck of the drill rnotor are some causes of elongated wells.

3.4.5.7.2 Dimpling

To install flush rivets in thinner sheet aluminum (1.0 mm, 0.040" thick or less), the material must be dimpled to form the well for the rivet head. This is accomplished by using male and female die sets to press the metal immediately surrounding the rivet hole into the proper shape to fit the rivet head. The rivet must fit the well snugly enough to obtain maximum strength. The number of sheets which can be dimpled simultaneously is limited by the capacity of the equipment used, but generally two sheets of relatively thin material of 0.5 mm (0.020") thickness can be dimpled simultaneously.

Both male and female dimple dies are machined accurately and have highly polished surfaces. The male die or punch is cone shaped to match the rivet head and has a small concentric pilot pin that fits into the female die and matches the diameter of the rivet hole. The female die has a corresponding degree of countersink into which the male die fits. The dimpling dies available from some sources are made so that their included angle is about 5° less than that of the rivet. This arrangement allows for spring-back of the metal and works especially well.

To dimple a hole, rest the female die on a solid surface, place the material on the female die, insert the male die into the hole to be dimpled, and then hammer the male die. Strike with several solid blows until the dimple is formed. Since the metal is stretched slightly during the dimpling process, the pilot hole of the female die should be smaller than the diameter of the rivet. After dimpling, the hole may be reamed to the exact diameter, using the appropriate drill bit, so that the rivet fits snugly. We recommend the use of a dimpling frame or a rivet squeezer to hold the dies.

3.4.5.8 Determining a Proper Size of Rivets

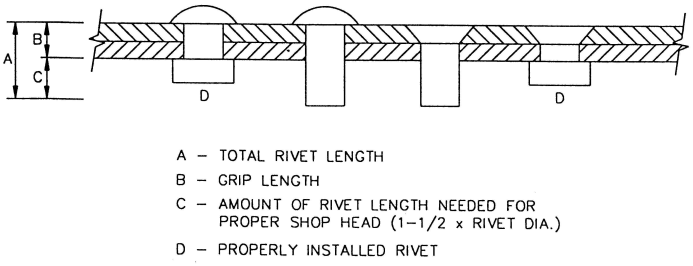
3.4.5.8.1 Diameter

Refer to the APPENDICES of this manual for list of rivets supplied in the EV-97 EUROSTAR MODEL 2000 VERSION R kit. The rivet designation includes both diamater (first number) and length (second number) – e.g. rivet 4x6 means the shank diameter 4 mm and shank length 6 mm. Which rivet to use is specified in the drawings and in assembly procedures, also.

3.4.5.8.2 Length

Read the Parts list of each sub-assembly (at the end of each section describing assembly sequences of a part of airframe) to see the rivet dimmensions.
In general, to determine the proper length of a rivet for installation, the combined thickness of the material to be joined, or the "stackup," must be known. This measurement is known as grip length. The total length of the rivet is equal to the grip length plus the amount of rivet shank necessary to form a proper shop head, which is 1-1 /2 times the diameter of the rivet shank . Referring to Figure 3 and the above information, use the formula A = B + C to determine the correct length of a rivet. (A is the total rivet length; B is the grip length; C is the material needed to form a shop head.)

Fig. Determining the Proper Length of a Rivet



NOTE

The length of a universal head rivet is measured from the underside of the head; the length of a flush (countersunk) rivet is measured from the upper surface of the head. Refer to Figure above.

A slightly longer or shorter rivet may be used if, after driving, the shop head conforms to the specifications given in the next section. A rivet of the correct size can be obtained by trimming a longer rivet with a rivet cutter.
If the combined thickness of the material to be joined is not known, and the location of the hole is such that the thickness cannot be measured directly, you can easily determine the grip length of a rivet by using a homemade tool. Simply bend a tiny 90° hook into the end of a stiff piece of wire. Insert the wire into the rivet hole and pull the hook back against the metal around the lower side of the hole. Mark the wire at the upper surface of the hole (either use a pen or simply hold your thumbnail against the wire), then withdraw the wire from the hole and measure the distance from the hook to the mark. Remember, this just gives you the needed grip length; you must add 1 -1 /2 times the rivet diameter to the grip length to determine the required total length of the rivet.

3.4.5.9 Installing a Line of Rivets

When driving a line of rivets in an assembly, start by driving a rivet at the center of the line and then one at each end. Then drive a rivet halfway between the center and the end on each side. Continue in this fashion, driving rivets at the centers of unriveted areas, until the entire line is finished. This practice tends to distribute any expansion of the material or any slight misalignments between the two parts along the entire length of the rivet line, resulting in a straighter assembly. If, on the other hand, you were to start at one end of the line and work your way to the other end, any slight misalignments or expansion would tend to be pushed along and to accumulate as you progressed. In this situation, you could force a curve into the assembly in order to get the rivet holes to line up as you go along, or you might be left with a bulge in the skin between the last two rivets.

3.4.5.10 Driving Standard Rivets

The essential tools for driving standard, solid-shank rivets are a compressor, a rivet gun, rivet sets and bucking bars. The rivet gun is used to deliver rapid, hammer-like blows that quickly drive the rivet when it is backed by a suitable bucking bar. The following types of rivets are used in building the EUROSTAR: flat head rivet, countersunk flush head, button-head rivet, and the blind pull type (discussed in 3.4.5.10.5). For each type of rivet, different techniques and tools are required. The universal head and flush head rivets obviously require different rivet sets. The blind rivets require only a pull riveter to install them. When using pneumatic rivet guns, hearing protectors are highly recommended. A rivet squeezer may be used for forming the standard, solid shank rivets in accessible areas, but accessibility is limited by the jaw depth of the squeezer. Installing rivets with a squeezer is much easier than with a pneumatic gun.

When riveting together material of different thickness, place the manufactured head against the thinner material wherever possible and form the shop head against the thicker material. This practice will minimize deformation of the material caused by riveting.

NOTE

Before driving any rivets, make sure that all holes line up perfectly, all shavings and burrs have been removed, and that all the parts to be riveted are securely fastened together.

3.4.5.10.1 Bucking

Two people, a "gunner" and a "bucker," usually work as a team when driving rivets. On some jobs, however, the riveter can hold a bucking bar with one hand and operate the rivet gun with the other.
Follow these general guidelines for bucking rivets:

1. Make sure the bucking bar has a flat, square face; otherwise, the rivet head will deform.
2. For the least distortion of the surrounding material, use as heavy a bar as practical.
3. Always hold the face of the bucking bar at right angles to the rivet shank. Failure to do this will cause the rivet shank to bend with the first blows of the rivet gun and will cause the material to be marred by the final blows.
4. The bucker must hold the bucking bar in place until the rivet is completely driven. If the bucking bar is moved while the gun is in operation, the rivet set may be driven into the surface of the material.
5. Position the bucking bar so that it clears surrounding obstructions, allowing the bucking surface to rest squarely against the tip of the rivet shank. Pad the bar with masking tape where it may contact the structure.
6. Avoid having the point of contact with the rivet too close to the edge of the bucking bar or it may slip off.
7. Do not bear down too heavily on the shank of the rivet. Allow the weight of the bucking bar to do most of the work. The hands merely guide the bar and supply the necessary tension and rebound action.

Prior to final rivet driving use a tightener (see Required tools table) to tighten the sheets being riveted.

Failure to hold the bucking bar at right angles to the rivet can cause defective rivet heads. A rivet going "clubhead" (malforming), can be corrected by rapidly moving the bucking bar across the rivet in a direction opposite that of clubhead travel. This corrective action can be accomplished only while the gun is in action and the rivet is partially driven. If a rivet shank bends at the beginning of the bucking operation, *place* the bar in the corrective position only long enough to straighten the shank.

3.4.5.10.2 Pneumatic Driving

In pneumatic riveting, the pressure for forming the shop head of the rivet is applied with a rivet set and an air-driven hammer or gun (see figure below). A rivet gun should be large enough to drive rivets in a reasonable length of time without distorting the structure. Be sure to choose the proper rivet set to match the type and size of the rivet you are driving.
Always use a regulator on your rivet gun and adjust it for the minimum pressure needed to drive the rivet. Adjust the speed of the gun (strokes per minute) before starting to drive rivets. To do this, press the rivet set against a block of wood before pressing the trigger.

Fig. Rivet set

CAUTION

Never operate the gun without resistance to the set; the vibrating action may cause the retaining spring to break, allowing the set to fly out of the gun. Also, free vibration may flare or mushroom the gun end of the set, causing it to bind in the barrel of the gun.

Hold the rivet set at right angles to the work to prevent damage to the rivet head or the surrounding material. Avoid using too many strokes without enough force because this may cause the rivet to work-harden and crack.

HINT

Use masking tape on the rivet set and on the bucking bar. The tape on the set protects the rivet head from marring; the tape on the bar helps to keep the bar from slipping off the rivet.

Remove the bucking bar and check the shop head of the rivet; it must conform to the standards described in 3.4.5.11 Specification for Properly Driven Rivets. If the rivet needs further driving, repeat the necessary procedures to complete the job. If the rivet has been driven too far (the shop head is less than 1 /2 times the shank diameter in height), it must be removed and replaced (see 3.4.5.12.1 Removing Rivets). In some cases, however, you may be better off leaving a rivet that has been driven too far rather than risk elongating the hole when removing the rivet.

We recommend practicing riveting on scrap material supplied in the "LEARNING KIT" to get a feel for the proper techniques before attempting to drive rivets in any of the airframe components.

3.4.5.10.3 Hand Driving

Since most standard solid-shank rivet joints (wing spars, center-section) in EV-97 EUROSTAR MODEL 2000 VERSION Rkit have already been done by kit manufacturer, there are some parts to be riveted. The hand driving is in this case the easiest way of driving.

In this method, the shank end of the rivet is driven with a hand set and a hammer (or just a hammer), and the manufactured head is bucked with a hand set held in a vise or a bottle bar (a special bucking bar recessed to hold a rivet set). This method is known as "reverse riveting"; it is commonly used in hand riveting, but is not considered good practice in pneumatic riveting.

Use a few slight strokes with hammer at the end of the rivet shank to form shop head, than use a tightener (a tube to tighten the sheets being riveted) and finalize rivet shop head.

When driving rivets by hand, keep hammer strokes to a minimum. Too much hammering can work-harden the rivet or the surrounding material, causing the joint to lose some of its strength. As with pneumatic driving, hold the bucking bar and rivet set square with the rivet at all times. After driving the rivet, verify that it conforms to the specifications for a correctly driven rivet, as described in 3.4.5.11 Specification for Properly Driven Rivets.

3.4.5.10.4 Squeeze Riveting

The squeeze method of setting a rivet produces the most uniform and balanced type of shop head. Each rivet is upset in a single operation; all rivets are formed with uniform pressure; and each rivet shank is sufficiently and uniformly expanded to completely fill each rivet hole. Squeeze riveters come equipped with pairs of end sets, each pair being designed for a particular type of rivet. Once the correct end set is selected and the squeezer is adjusted for a particular application, all the rivets will be driven uniformly, thus providing an efficient method of riveting. Access for squeeze riveting is limited by the jaw depth of the riveter, so this method can be used only near the edges of components.

The procedures for installing rivets by squeezing will)vary depending on the type of rivet squeezer you are using, but, in general, follow these steps:

1. Carefully select and insert suitable sets to match the rivet being used. This is very important; it is impossible to buck the rivet properly unless the correct pair of sets is used.
2. Adjust the gap to conform to the length of the rivet being installed. The gap adjustment method varies with the type of squeezer: usually either a gap regulator controls the stroke of the jaw (adjusted by rotating the plunger that holds the moving set) or shims adjust the spacing between the sets.
3. Before using the squeezer on the work, test the accuracy of the gap adjustments on a piece of scrap material. The scrap must be the same thickness as the work to be riveted, and the rivets must be the same length and diameter.
4. If the parts to be riveted are small and easily handled, mount the rivet squeezer in a bench vise or a special clamp and hold the parts to be riveted in your hand.

Consult the instructions included with your rivet squeezer for specific details..

3.4.5.10.5 Blind Riveting

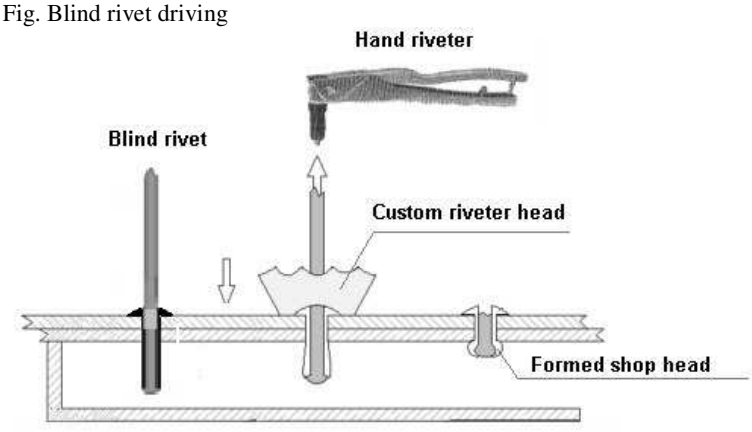
Blind riveting will be your main operation to assemble your EV-97 EUROSTAR MODEL 2000 VERSION R.
These rivets are called "blind rivets" because the shop head is not visible during or after forming. They are also called "pull rivets" because the shop head is formed by pulling a solid mandrel into the hollow rivet shank from the accessible side.
Although the blind rivets supplied with the EUROSTAR kit may resemble the Pop rivets available at your neighborhood hardware store, there are important differences. All of the pull rivets used on the EUROSTAR are aircraft-quality rivets, in which the stem fills the hollow shank of the rivet after pulling, providing much greater shear strength. On common Pop rivets, by contrast, the stem breaks off short during installation, leaving a structurally weak empty shank.

WARNING
Do not use standard, hardware-store Pop rivets in the GIaStar airframe. Use only the rivets supplied with the kit.

Installing blind rivets is pretty straightforward. Holes are drilled and deburred in the same manner as for standard rivets except that greater care must be taken not to enlarge or elongate the hole. This is because a blind rivet will not expand as much as a solid shank rivet. Use the correct pulling tool and make sure that the proper pulling head is installed on the tool for the size of rivet being used. After the hole is drilled and the parts are clean and clamped securely together, insert the rivet fully into the hole, position the head of the pulling tool on the rivet stem (mandrel) and pull the rivet stem until it snaps. After pulling, inspect the rivet: the head must fit tightly against the metal and the stem should snap off flush with the head of the rivet. Sometimes the stem will break off above the rivet head in which case you must simply file it down flush with the rivet head.

The blind rivets are set with a standard hand riveter, with customized heads (nose bushing piece). The Avex blind rivets are very easy to set, and require access from one side only (compared to solid rivets which require access from both sides). Hold the hand riveter perpendicular to the material as you pull a rivet, pushing down on the riveter (against the material) as you squeeze. Make sure material is deburre before riveting (all surfaces, both sides) and EMFIMASTIC sealant is applied on the sheets (if prescribed).

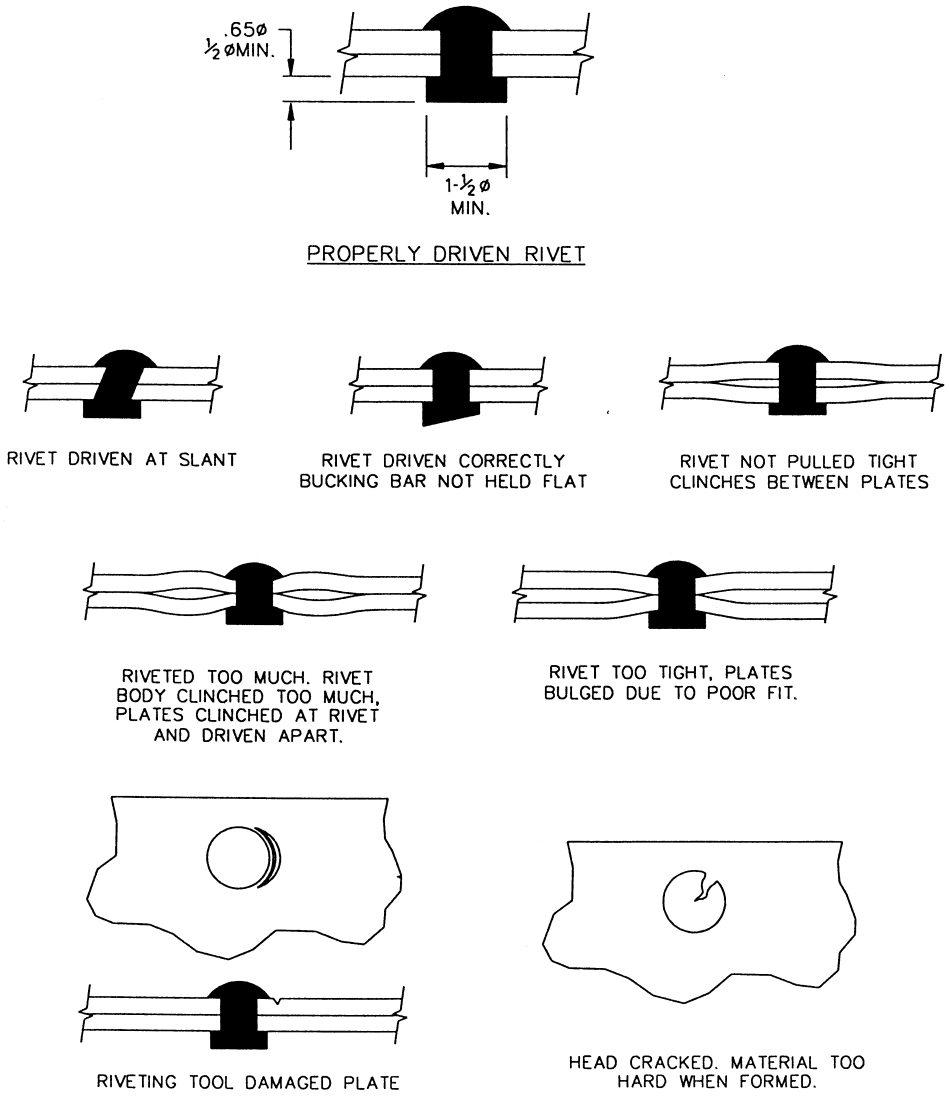
Fig. Blind rivet driving



3.4.5.11 Specification for Properly Driven Rivets

After driving, the shop head should be a minimum of 1 -1 /2 times the diameter of the rivet shank in width and about 2/3 the diameter of the rivet shank in height. The minimum acceptable height of the shop head is 1 /2 the shank diameter. See Figure below for examples of properly and improperly driven rivets.

Fig. Properly and Improperly Driven Rivets



3.4.5.12 Replacing Defective Rivets

The design of riveted joints is based on the theory that the total joint strength is simply the sum of the individual strengths of each of a whole group of rivets. It is obvious that if any one rivet fails, its load must immediately be carried by others of the group; if they are unable to carry this added load, progressive joint failure then occurs. Consequently, an inspection must be made of all rivets before an assembly is put into service. This inspection consists of examining both the shop and manufactured heads and the surrounding skin and structural parts for deformities. A machinist's scale or a special rivet gauge can be used to check the condition of the shop head to see that it conforms to the specifications. The eye alone can detect deformities in the manufactured head. Use a straightedge to check that flush head rivets are neither protruding above the skin surface nor recessed too deeply below the surface.

Some common causes of defective rivets are improper bucking, rivet set slipping off or being held at the wrong angle, and rivet holes or rivets of the wrong size. Additional causes of unsatisfactory rivets are countersunk rivets not flush with the well; work not properly fastened together during riveting; the presence of burrs; and too much or too little driving. Whatever the cause, defective rivets must be removed and replaced.

NOTE

Stop and inspect your work at important milestones before proceeding with further work that will make defective rivets inaccessible for replacement.

3.4.5.12.1 Removing Rivets

When removing a rivet for replacement, be very careful to maintain the original size and shape of the rivet hole so that replacement with a larger size rivet will not be necessary. If the rivet is not removed properly, the strength of the joint may be weakened and replacement of rivets made more difficult.

When removing a rivet, work on the manufactured head. It is more symmetrical about the shank than the shop head, and there will be less chance of damaging the rivet hole or the material around it. The preferred is to drill through the rivet head and then to pull the tail out with a pair of flush cutting diagonal cutters, or to simply drill all the way through. On heavier structure, drill through the head and then drive out the remainder of the rivet with a pin punch. The dimple in universal and flush head rivets usually eliminates the need to center punch the rivet head, but you may center punch the head anyway to reduce the tendency of the drill bit to walk off the head. For blind rivets, use a small pin punch to drive the remains of the stem down into the rivet; the hole in the middle of the head then centers the bit for drilling.

NOTE

On thin sheet metal, back up the rivet on the shop head side to avoid depressing the surrounding metal when center punching a bucked rivet or driving out the mandrel of a blind rivet..

Select a drill one size smaller than the rivet shank and drill out the rivet head. When using a drill motor, set the drill bit on the rivet head and rotate the chuck several revolutions by hand before pulling the trigger. This procedure helps the drill cut a good starting spot and reduces the chance of the drill slipping off and tracking across the metal. Drill the rivet to the depth of its head, while holding the drill at a 90° angle. Be careful not to drill too deeply because the rivet shank will turn with the drill and elongate the hole. The rivet head will often break away and climb the drill bit, which is a good signal to withdraw the drill. If the rivet head does not come loose of its own accord, insert a pin punch of the proper size into the drilled hole and rock it back and forth slightly until the head comes off.

Drive out the shank of the rivet with a pin punch slightly smaller than the diameter of the shank. On thin metal or unsupported structures, support the sheet with a bucking bar or a block of wood while driving out the shank, or pull out the shank from the back side with a pair of diagonal cutters. If the shank is exceptionally tight after the rivet head is removed, drill the rivet about two thirds of the way through the thickness of the material and then drive out the remainder of the rivet with a pin punch.

The procedure for removing flush rivets is the same as just described. Be very careful to avoid elongation of the dimpled or countersunk holes. Drill the rivet head to approximately one-half the thickness of the top sheet.

CAUTION

If you want to remove a skin or other part riveted to the airframe with blind rivets, you should first remove all blind rivets and then heat the joint by means of a heat gun. It is by reason that almost all blind rivet joints are cemented with EMFIMASTIC sealant.

3.4.6 Nutplate Installation

Nutplates (also called "anchor nuts") are used in inaccessible areas where a regular nut cannot be used. As shown in the following Figure, installing nutplates is simple but requires following a specific sequence:

1. Drill the bolt hole through both parts.
2. Insert a bolt through the hole from the top side and thread the nutplate partially onto the bolt.
3. While the bolt holds the nutplate in alignment, use one of the rivet holes in the nutplate as a guide to drill the first rivet hole.
4. Insert a Cleco or a rivet through the first rivet hole to maintain alignment.
5. Drill the second rivet hole.
6. Remove the nutplate, deburr the rivet holes and countersink or dimple the holes on the top side. (If you dimple, as you should on thin material, then you will also have to dimple the flanges of the nutplate, or else it will not lie flat against the part when riveted.
7. Rivet the nutplate in place.

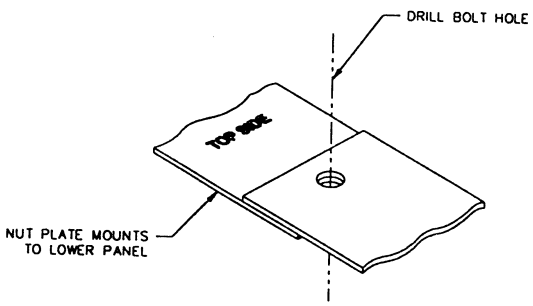
NOTE

If the nut plate is to be mounted in a location that is inaccessible for drilling from the bottom side, insert the bolt through the hole from the bottom, thread the nut plate onto the bolt and drill the rivet holes from the top side.

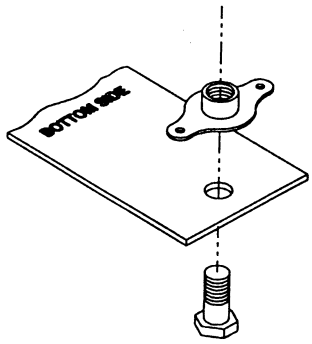
HINT

Special nut plate jig tools are available to simplify the installation of nut plates. The tools have a pin that fits into the bolt hole and two drill guides of the correct size and spacing for drilling the rivet holes. A different tool is needed for each size of nut plate.

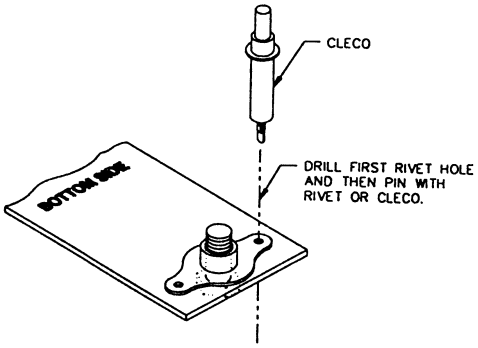
Fig. Nutplate Installation Procedures



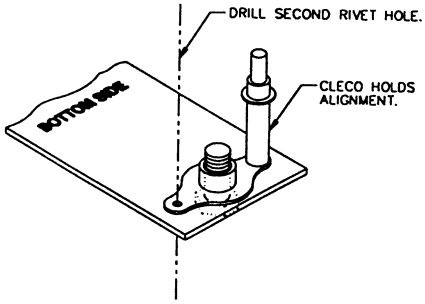
STEP 1



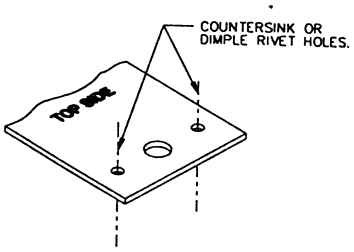
STEP 2



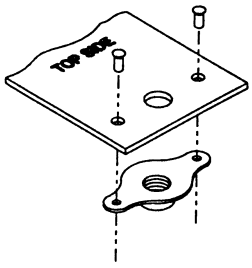
STEP 3 & 4



STEP 5



STEP 6



STEP 7

3.4.7 Rivet-nuts

Rivet nuts can be used in wide range of applications and are designed to provide a very cost-effective method of placing permanent threads in thin material. Installed from one side, rivet nuts are for use in metal, fiberglass and rigid plastic previously too thin for tapped threads. Once in place the internal thread of rivet nut is ready for a screw or bolt.
Lightweight tooling assures easy installation by the operator and reduces costs when compared with other methods of installation, rivet nuts provide permanent, captive threads that resist high loads, do not allow loosening due to vibration and will not rotate when attached to the matting material.

Rivet nut installation procedure is the following:

1. Drill hole to correct diameter, thread fastener onto tool mandrel and insert into hole
2. Actuate tool to properly set fastener into material
3. Complete your fastening operation with a bolt or screw with proper thread

Fig. 3 Easy Steps for Installation

Fig. Rivet nut Section

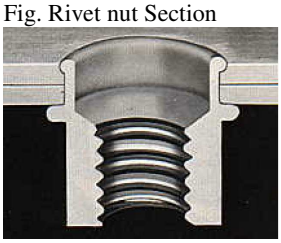


Fig. Hand riveter for rivet nuts

3.4.8 Fiberglasses

3.4.8.1 What Is Fiberglass?

Glass fiber is produced by drawing single fibers of special glass (largely silicon, calcium and aluminum dioxides) into very small-diameter strands. The glass itself has very high tensile strength, little corrosion resistance and is vulnerable to attack by both acids and alkalis. When the properties of glass fibers are properly complemented with the corrosion resistance and toughness of resin, however, the end product is a strong, lightweight, corrosion resistant material known by the generic name "fiberglass reinforced plastic" (FRP).

3.4.8.2 Fiberglass Parts in the EV-97 EUROSTAR MODEL 2000 VERSION R.

In spite of the fact, that EV-97 EUROSTAR MODEL 2000 VERSION R airplane is of all metal construction, there are some parts made more easily from fiberglasses.
The following finished fiberglasses parts are supplied in the EV-97 kit:

	No.	Nomenclature	Part	Pieces
Standard kit	1.	760501	Wing root fairing - left	1
	2.	760502	Wing root fairing - left	1
	3.	761540	Instrument panel upper frame	1
	4.	761284	Wing tip - left	1
	5.	762384	Wing tip - right	1
	6.	763462	Stabilizer tip	2
	7.	763838	Tail unit-fuselage fairing	1
	8.	763839	Fin tip	1
	9.	763912	Rudder tip	1
	10.	763923	Rudder root rib	1
	11.	766241	Rotax engine upper cowling	1
	12.	766242	Rotax engine lower cowling	1
	13.	766069	Radiator hose attachment piece	1
Optional equipment	14.	765271	Main wheel fairing	1
	15.	765471	Nosewheel fairing - front	1
	16.	765472	Nosewheel fairing - rear	1
	17.	765473	Nosewheel leg fairing - front	1
	18.	765474	Nosewheel leg fairing - rear	1

3.4.8.3 Materials used in the Fiberglass

Below listed are producers and vendors of component to fabricate the fiberglass parts suppied in the kit of EV-97 EUROSTAR MODEL 2000 VERSION R airplane.

- Fiber glass clothes
  Producer: VERTEX Litomyšl, Czech Republic
  Vendor: POLYVIA NOVA s.r.o., Nad Vývozem 4844, Zlín, Czech Republic
- Epoxy resin
  VIAPAL UP 600S/70
  Producer: VIANOVA, Austria
  Vendor: POLYVIA NOVA s.r.o., Nad Vývozem 4844, Zlín, Czech Republic
- Gelcoat
  GP 2000 S
  Producer: JOTUN, Norway
  Vendor: REINCHOLD SPOLCHEMIE a.s., Ústí nad Labem, Czech Republic
- Starting Catalyst
  PEROXIMON K 1
  Producer: ELF ATOCHEM ITALIA S.rl., Italy
  Vendor: REINCHOLD SPOLCHEMIE a.s., Ústí nad Labem, Czech Republic

3.4.8.4 Laminating Procedure to Fabricate a Fiberglass Part

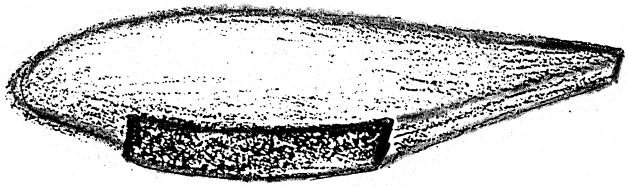
Although all the fiberglass parts are supplied in the kit still finished and prepared to attach to the airframe (trimming is sometimes needed, only), we'd like to provide you with a standard laminating procedure to fabricate a part to make you familiar with this technique.

Below described is a one of possible procedures to fabricate the fiberglass part
- Main wheel fairing:

1. Fabricate the model of a part (main wheel fairing)
2. Fabricate the mold
3. Fabricate the laminate part (main wheel fairing)

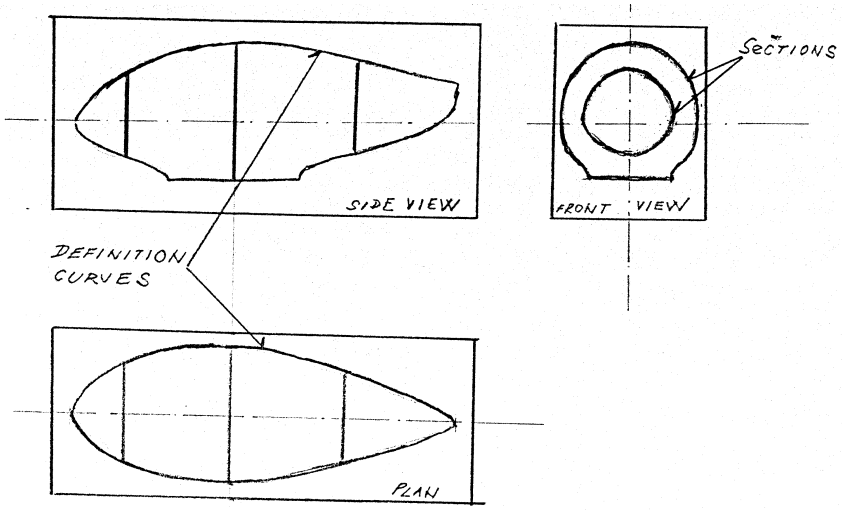
1. Fabricate the model of the main wheel fairing

FIG. MAIN WHEEL FAIRING



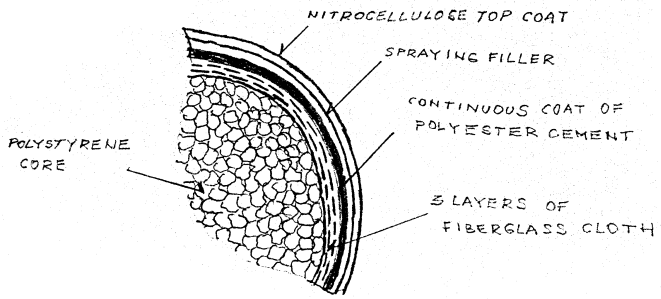
1.1 Setting the definition curves and sections of the part to be fabricated.
Define and draw the side view, plan, sections at maximum height and width.
Fabricate the templates of defined sections; the templates are needed to shape a polystyrene block. Use a Formica or sheet to fabricate required templates.

FIG. DEFINITION CURVES AND SECTIONS



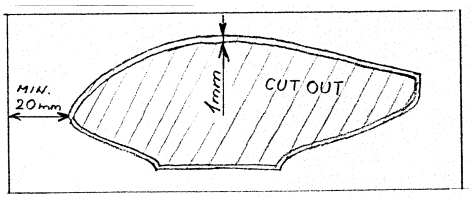
1.2 Fabricate the polystyrene mold
Prepare the squared polystyrene block, to cut the block use a resistant wire.
Attach the Side view template to the block and saw at required shape by means of the resistant wire, then attach the Plan template and proceed sawing to prepare a rough shape of the model.
Then use a coarse-grained sand paper to finish the rough shape of the model.
Check model for keeping the shape and symmetry by means of the templates.
Finish the model shape by means of a fine-grained sand paper, the shape must be relief ground 2-4 mm.
Clean the model surface - blow out the grindings.
Laminate the model with 2-3 layers of the fiberglass cloth; laying order for example 350, 350, 150 gr/m2.
Sand the model after resin cure, the surface should be roughen prior to application of the polyester cement. Blow out grindings after sanding.
Apply a continuous coat of a polyester cement on the roughened model surface by means of a spatula. Suitable is a quick-hardening polyester cement used for car body repairs.
Proceed with cement application and sanding to finish the model at required shape and dimensions.
Check model for surface waviness and shape local inaccuracy., correct by applying the cement and sanding, if necessary.
Apply a spray filler after model shape finishing, wet sand, dry, prime, apply a nitrocellulose top coat and polish the surface at high luster.

FIG. FINISHED MODEL CROSS SECTION



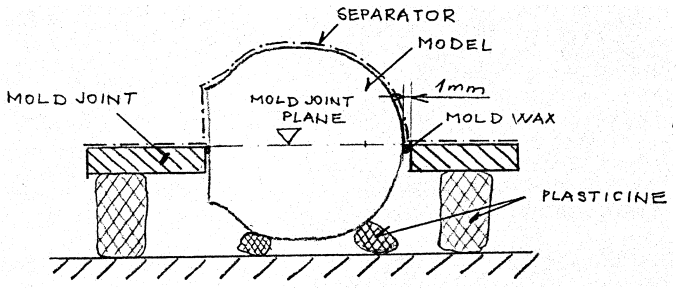
2. Fabricate the mold
2.1 Fabricate the mold joint
Usually the mold joint is suitably located in the widest (highest) place of a section to make easy the part release from the mold. Preferable material to fabricate the mold joint is a flat, smooth board. Refer to the Figure below for the wheel fairing mold joint, make a cut out pursuant to the side view curve (use a template). The cut out being done should have a clearance of 1 mm.

FIG. MOLD JOINT



2.2 Position the mold joint
See the Figure below to position and level the mold joint by means of a plasticine.

FIG. MOLD JOINT

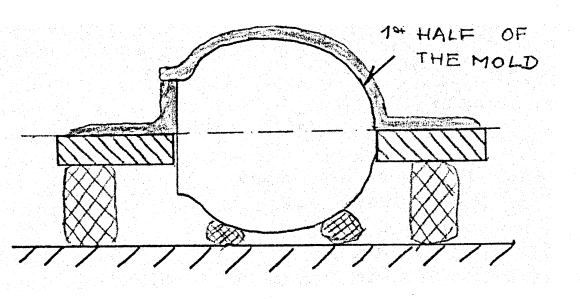


Apply a special mold wax or silicone sealant into a gap between the joint and model.

2.3 Model surface and mold joint separation
The model surface and mold joint board must be separated by applying a special mold release wax or a good quality automotive paste wax. The wax applied must be inert to the epoxide resin.

2.4 Laminating the mold
Apply the first thin layer of epoxy resin or epoxy compound on the prepared and separated model and mold joint board.
Take care of applying the entire surface of the model and mold joint board.
Let 2 hours to cure the first resin layer, then lay the cloth down as neatly as possible, saturate with resin, proceed with next layers of the cloth and resin:
1st layer - 150 gr/m^2
2nd layer - 240 gr/m^2
3rd layer - 500 gr/m^2

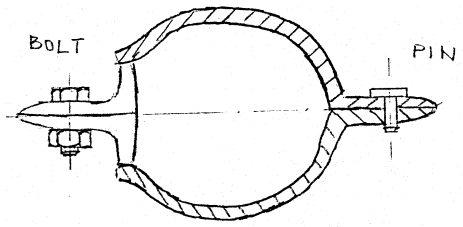
FIG. LAMINATING THE MOLD



After curing of the first half of the mold, release the mold joint board, separate it again, position the mold joint on the model and laminate the opposite half of the mold following above described procedure.

After curing of the second half of the mold drill a line of holes through both halves for mold halves connecting bolts and pins.
Then release the mold from the model. Check the interior of the mold, correct if necessary using the polyester cement, sand and clean the mold surface.

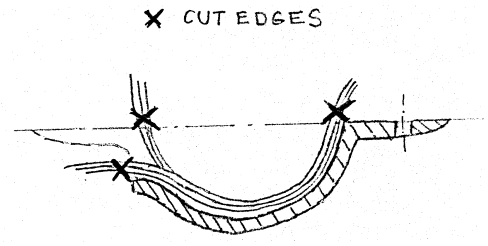
FIG. MOLD HALVES CONNECTING PINS AND BOLTS



3. Fabricate the laminate part (wheel fairing)

Prior to laminating the part, the mold must be cleaned and separated analogous to the Model surface separation. Apply the first thin layer of the epoxy resin to the area to be laminated, take care of applying the entire required surface of the mold.
Let become dry 2 hours and lay down the first layer of the fiberglass cloth, which adheres to the epoxy resin very well. Then proceed with saturation and laying down of the remaining fiberglass clothes. The resin quantity applied should be minimized (but enough to saturate the cloth!) and the fiberglass cloth layer should be maximized. The orientation of weaves and number of cloth layers is generally chosen pursuant to the laminate part size and its function - e.g. for the main wheel fairing: 1x 150 gr/m^2 + 2 x 300 gr/m^2.

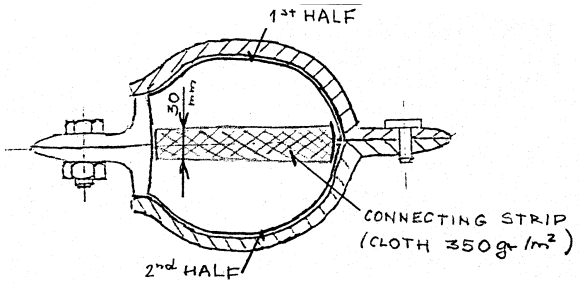
FIG. CUT EDGE WITH A KNIFE AFTER 5 HOURS



See Figure above to cut the cloth edge after 5-6 hours. When both halves of the wheel fairing are finished, do not release them from the mold, but only trim and deburr the edges of the part and then assemble both halves of the together with attachment screws and pins.

Prepare a strip of fiberglass cloth 350 gr/m^2, saturate with resin, insert inside into the laminated part through the hole for the wheel and lay the strip down to connect both halves of the wheel fairing.
Release the laminate part from the mold after resin curing.

FIG. CONNECTING BOTH HALVES OF THE FAIRING



Sand the surface, apply a polyester cement to correct surface roughness. Then apply spray filler, wet sand the surface, prime and spray top coat.

3.4.8.5 Recommended Reading

AC 43.13-1A Acceptable Methods, Techniques and Practices Aircraft Inspection and Repair.

3.4.9 Cables

Cables are used to control the rudder, trim tab and steerable nosewheel of EV-97 EUROSTAR MODEL 2000 VERSION Rairplane. Cables are also used to attach the fuel tank to the fuselage and safety belts to the bulkhead behind the baggage compartment.
Therefore you will need to master the following fairly simple cutting, NicoPress installation and safetying procedures.

3.4.9.1 Cable Sizing and Cutting

Using methods described below, you'll be able to cut your control cables to precise final length, but first you need to cut each cable to rough length. First, install the terminal hardware on one end with the techniques described below. Then secure that end of the cable to your workbench with a nail or clamp and stretch the cable tautly to the required length plus 150 mm (6"). The extra length will be used in making the second terminal splice.

If you have a cable cutter, that's obviously the best way to cut cable, but a bolt cutter or a sharp cold chisel used against a hard metal surface will work as well. In using a chisel, be sure to hold it perpendicular to the cable and hit it hard! Your goal is as sharp and clean a cut as possible.

HINT

Before making a cut, wrap the area of the cut with masking tape. Not only is the tape easier to mark than the raw cable, but it will also minimise fraying of the cut ends, which in turn will make it less likely that you'll impale your fingers on sharp, loose cable strands!

3.4.9.2 Nicopress Sleeve Installation

The prettiest connections between control cables and terminal hardware are swaged splices, but unless you have special access to a very expensive swaging press, you'll probably want to make do with the NicoPress splices supplied with the EUROSTAR kit. This is no sacrifice in any but aesthetic terms - NicoPress splices are every bit as strong as swaged joints, which is to say as strong as the cable itself.
Figure below illustrates the process of making a NicoPress splice.
The first step is to run the cable through the sleeve, loop it around the thimble, and feed the end back through the sleeve. Be sure to leave sufficient length extending beyond the sleeve – 25 mm (an inch) or more is fine. If you're careful, it's easier to cut off excess when the splice is finished than it is to start over if you come up short. Also, before crimping the sleeve, remind yourself what kind of hardware will ultimately be connected to the terminal you're working on; if it's an eye or a particularly tight shackle, for example, it has to go through the thimble before you make the splice! You can save yourself a little cable and a lot of frustration by thinking ahead at this point.
With the thimble in place, slide a cable clamp over the loose end of the cable and push it tightly up against the sleeve. When you have pulled the loose end as tightly as you can around the thimble, tighten the cable clamp to hold the cable in place. Use the NicoPress pliers to make the first of three crimps in the center of the sleeve. Before you squeeze, make sure you've seated the sleeve firmly in the proper notch for the sleeve size you're using - the tool will have several notches, only one of which is right. Squeeze the handles until they are completely closed; incomplete crimping will result in a weak, unacceptable splice. After the first crimp, the second should be made beside the first on the side closest to the thimble or bushing. Finally, the third crimp should be made on the other side of the first. Remove the cable clamp before making the final crimp, because the sleeve lengthens somewhat when crimped.

HINT

Clamp one handle of the NicoPress tool in a bench vise to make this an easier one-person operation.

HINT

Some builders like to clip the sharp points off thimbles before making a NicoPress splice. This allows the sleeve to be positioned more tightly against the thimble.

When all three crimps have been made, use the "go, no-go" gauge that comes with the NicoPress pliers to check the width of the crimps. The widest part of the crimped section should slide easily into the appropriate slot in the gauge. If it doesn't, that means the sleeve was insufficiently compressed, and the splice will not be full strength as a result. Try crimping it again to make it fit the gauge, but be careful-the finished crimps should be round and smooth, and if the second crimping leaves the sleeve buckled or cracked, you'll have to abandon the splice and start again.
At least 3 mm (1/8") of cable should protrude beyond the end of the sleeve when the splice is completed. After you are satisfied with the splice, cut off any excess beyond that length.

CAUTION

When cutting excess off the end of a cable, be extremely careful not to nick the working cable with your cutters or chisel. Severing a single strand of the working cable is sufficient reason to discard it and start again.

For a cleaner-looking and safer splice, slip a short length of clear heat-shrink tubing over the cable before you slip the sleeve-on. When the splice is completed, slide this tubing over the loose end of the cable until it's tight up against the NicoPress sleeve and shrink it down. This tubing will keep those razor-sharp strand ends away from you when you're connecting or adjusting the cables and at the same time because of its transparency-will allow easier inspection of the terminal splices during pre-flight and annual inspections.

Fig. NicoPress Splicing

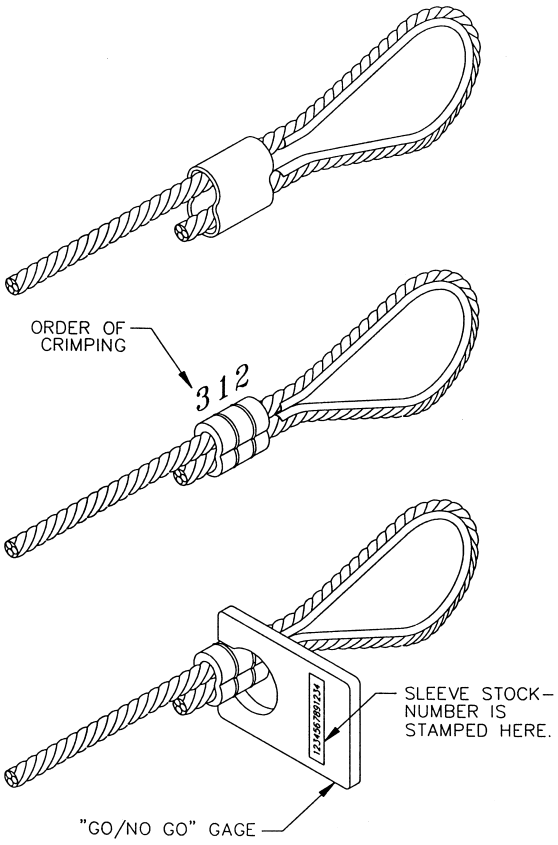
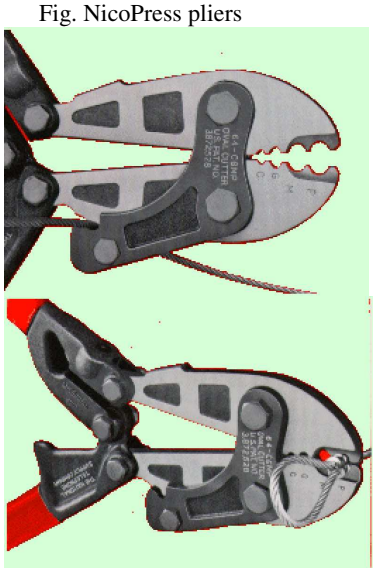


Fig. NicoPress pliers



3.4.9.3 Cable Tightening

The tension of cables which control the rudder is induced by a rubber rope, one end of that rope is attached to the firewall and the second to the pedals.

The tension of cables attaching the fuel tank to the fuselage framework is adjusted by means of a turnbuckle. Also the steerable nosewheel cables tension is adjusted by means of turnbuckle.

3.4.10 Welding

Below listed are some examples of welded parts supplied in the kit of EV-97 EUROSTAR MODEL 2000 VERSION Rairplane:

Steel parts: Nosewheel leg, engine bed, exhaust manifold, oil tank bracket, engine bed suspension, canopy frame, some parts of hand and rudder control, main wheel axis brackets, flap control and some other parts.
Aluminum parts: Fuel tank, pitot tube bracket and some other parts.

Since the parts are supplied in the kit still welded, you don't need to weld anything. But if you decide to install other than ROTAX 912 engine, you shall have to weld a new engine bed and probably other engine equipment.
For your information and education we include some basic information concerning welding, but we highly recommend you to read e.g. AC No. 43.13-1A.

The welded parts can be divided in two groups according to the materials being welded:

3.4.10.1 Steel parts

Most welded parts are made from chrome-molybdenum high-quality steel especially suitable for welding and heat treatment. This steel is marked by L-CM3 (4130 U.S.A equivalent) in this Assembly Manual and in other documents.
The arc welding is used to weld steel parts, the arc burns between the tungsten electrode and the material being welded, therefore the abbreviation for this method is TIG i.e. Tungsten Inert Gas. The welding process is shielded by argon atmosphere.
The weld bead is formed by filler wire. The weld is of high purity and therefore not susceptible to cracking.
The welded parts are then normalized or heat treated. The quality of the weld is checked visually, important parts are inspected by electromagnetic test or X-ray inspection. The surface of each welded part should be protected for example by painting or electro-galvanized.
The typical welded steel part is the engine bed.

3.4.10.2 Aluminum Alloys

Only the Aluminum alloys which guarantee high quality welds are used for EV-97 EUROSTAR MODEL 2000 VERSION Rairplane.
There are used Al-Mg-Mn alloys for this purpose. The materials supplied in the kit is marked:

	U.S.A equivalent
Z 424400	6061
Z 424412	5052
Z 424432	3030

The welding process is the same as for steel parts i.e. TIG method, argon arc shielding.
All the parts to be welded must be cleared of oxides and therefore are pickled.
The welds are visually checked for quality. The technology and materials used guarantee the high quality of welds. The surface of welded parts is protected by painting.
The typical welded aluminum part is the fuel tank.

3.4.10.3 Welding Importance

WARNING

By reason that the welded parts are generally the most important and structural parts, we strongly recommend you to let a professional welder to do it, especially if you are not familiar with welding and have no skills.

As mentioned at the beginning of this Section, the parts supplied in the kit are still welded and you shall weld only the parts necessary to install other than ROTAX 912 engine.

3.4.11 Corrosion Protection

Corrosion of metal components is a potentially serious problem, arid steps should be taken to prevent it. However, the degree of protection required depends to an extent on the environment in which the aircraft will be operated. Protection that is adequate for a plane based and primarily flown inland would not be sufficient for a floatplane or a plane based and flown near salt water. On the other hand, the level of protection required for the latter environments might be unnecessarily expensive and time consuming for the former. So, as the builder you will have to judge the sort of environmental demands you'll be placing on your airplane. The following information should help you to make and carry out an appropriate choice.

3.4.11.1 Parts Required Protection

Most all the steel parts in the EUROSTAR kit are zinc plated (and often painted as well) at the factory and thus require no further anti-corrosion treatment.
All the duralumin sheets are Alclad, which means that the alloy part is clad in a thin layer of pure aluminum. Because pure aluminum is more susceptible to corrosion than the underlying alloy, corrosion is confined to the thin surface layer and the underlying alloy is preserved. Therefore, Alclad parts are probably sufficiently corrosion resistant without further treatment for most land-based use.
However, there are some structural components such as ribs which are not Alclad and are painted to ensure protection.

CAUTION

The Alclad coating is extremely thin. Any scratches that penetrate the coating allow corrosion to take root in the underlying alloy. For this reason, don't sand or buff any Alclad surfaces (except to prepare for painting) and be careful to avoid inadvertent scratches. If an Alclad surface becomes scratched, it must be treated as unclad metal.

At a minimum, we recommend that you provide some extra corrosion protection at key locations in the interior structure. Such locations include anywhere the Alclad outer skins have been drilled or cut (since this breaches the protective coating) and anywhere two different alloys meet. If you anticipate the operation in the seaside regions, then a comprehensive interior treatment is recommended for all ribs, spars, skins and fittings.

3.4.11.2 Protection Methods

Any corrosion protection treatment consists of at least two steps: cleaning the surface and applying a primer. An additional step-variously referred to as conversion coating, etching or roughing-can be added between cleaning and priming for maximum protection.

3.4.11.3 Cleaning Surface

Cleaning is necessary to remove deposits of oil and dirt that would inhibit the bonding of the primer to the metal. Good cleaning results can be achieved with a simple water-and-detergent wash or with a degreasing solvent such, acetone. Ordinary paint thinner or lacquer thinner should be avoided because it merely dilutes the grime and spreads it around.) With either detergent or solvent, a non-metallic scrub pad (such as Scotch Brite brand) and some elbow grease will ensure a more thorough cleaning.

CAUTION

Never use steel wool to clean aluminum parts or surfaces. The tiny particles of steel left behind can be extremely difficult to remove completely, and any that remain will bring about the very thing you're trying to prevent by causing dissimilar metals corrosion. If you use a water-based cleaning technique, it's very important to make sure the part or surface is completely dry before priming. Use of a heat gun is recommended. Avoid using compressed air, because the air stream likely contains small amounts of oil and water from the compressor, which will recontaminate your newly cleaned surface.

NOTE

When cleaning metal for priming, be especially careful to remove any pencil or felt-tip pen marks you may have made during assembly. These can require extra scrubbing to remove, but if allowed to remain they will bleed through most primers, allowing corrosion a toehold.

3.4.11.4 Conversion Coating

After a part or surface has been cleaned and dried, primer can be applied directly. However, any primer can be made to bond better-and thus an extra level of protection can be achieved-by giving it a slightly roughened surface to adhere to. This microscopic roughening can be achieved physically-by wet sanding with 400-grit sandpaper.(or a coarse Scotch Brite pad) and more of that elbow grease-or chemically-through the application of an acid etch. The latter involves wiping or spraying a water-diluted acid solution on the parts. After two or three minutes, the solution is washed off with sprayed water. After careful drying, primer can be applied directly to parts which have been acid etched, but you can get even better protection by following the acid etch with an alodine treatment. This can be applied even before the parts are dry after being acid etched, because the alodine solution is also water soluble.

As a rule, acid etching is probably the simplest method of preparing aluminum parts for priming. Wet sanding is a reasonable method for large, flat surfaces, but would be somewhere between tedious and impossible for small or irregularly shaped parts (like wing or stabilizer ribs, for example). Ultimately, the method you choose also depends in part on what primer you're using. Follow the recommendations of the primer manufacturer for best results.

3.4.12 Electrical System

3.4.12.1 Introduction

A detailed description of all the questions relevant to the electrical system of your airplane is almost not possible because of diversity due to varying requirements of each builder.
Because of this diversity, only fundamentals of electricity and basics are discussed in this Assembly Manual.
There are a number of sources for information concerning aircraft electrical systems and wiring practices; refer to those sources for more details (see Recommended reading).
We recommend you to contact an electrical engineer and/or firm, which dispose of special tool and instruments and have Know-how; especially if you are not familiar with wiring practices.
This way you eliminate a need to buy rather expansive tools, measuring instruments, and avoid often occurred troubles with your airplane's electrical system debugging and putting into operation.
If you decide, that you want to install the electrical system yourselves, we provide you with fundamentals to be known prior to installation.
Proper planning of your electrical system is absolutely essential. Do not wait until you are in the middle of the building process to think about this. You will need to route electrical wiring (e.g. pos. lights, ant. beacon, etc.), determine the best location for your battery, think about where to put a bus bar, etc. during initial building stages.
We can supply the builders, which decide to install standard Rotax 912 engine and basic equipment (pos. lights, ant. beacon, GPS, COMM B&K KY 97A, etc.), with schematic diagrams and more information needed to install those instruments properly.
The basic wiring scheme is also enclosed in Appendices of this Assembly Manual.

3.4.12.2 Basic steps involved in wiring

The basic steps involved in wiring your amateur-built airplane EV-97 are as follows:

- Determine what electrical equipment you are going to install
- Locate the equipment in the aircraft
- Locate the battery, bus bars, and circuit breaker/fuse panels on the airframe
- Calculate wire size and circuit breaker/fuse requirements
- Connect the electrical equipment to a power source
- Ground and bond properly
- Install proper instrumentation to monitor the system
- Complete a detailed schematic drawing of the system

3.4.12.2.1 DETERMINING EQUIPMENT REQUIREMENTS

The first step is to decide what electrical equipment you want to install on your aircraft and then calculate the current draw in amps each piece will require. You may want to install position lights, anticollision beacon, landing lights, COMM, GPS, etc. Decide now what to install then calculate the current draw of each item.

The current draw is often listed on the electrical component or it is available from the manufacturer. You will need to know the current draw in amps. This can be determined by using Ohm's law (shows the relationship between electrical current flow I, pressure E and resistance R $\Rightarrow$ E=I*R) or, more commonly, the wattage will be given and you can then use the power formula expressed as Power = Voltage X Current. Using this formula you can then find the current draw in amps by dividing the watts by the voltage. This number will be needed later to determine the size of wire needed for the piece of equipment.

You should also decide the system you are going to install - the EV-97 EUROSTAR MODEL 2000 VERSION R standard electrical system is single-wire type with the negative connected to the chassis. As a power source serve the single-phase generator integrated to the engine and the 12V/16Ah maintenanceless battery located on the firewall. The system is protected by the main circuit breaker positioned on the instrument panel. The circuits of the particular sections are guarded separately by fuses.

If you are going to install other than Rotax 912 engine, begin to develop your schematic diagram at this point; we supply you with basic schematic diagram enclosed in Appendices of this Assembly Manual. Do not hesitate to contact us for more information or if you are in doubt.

3.4.12.2.2 LOCATE THE EQUIPMENT

It is very important to plan where you will place your electrical items. If you are planning to install strobes, landing lights, navigation lights, etc. you will want to route the wiring needed for both power and ground. In many aircraft designs, this must be completed during the early phase of assembly. Otherwise, you may find that you will be unable to route electrical wire or certainly find it to be a very difficult task. After locating equipment, route the necessary wiring being sure to identify each wire. You can identify each wire by using tape that is folded over and marked. The size of wire will be discussed in a later step. Use black wire for grounding of equipment so it is easily identified. Continue your schematic as you locate equipment.

The standard location of EV-97 electrical equipment and instruments is described in the following:

- Battery – the battery bracket is attached to the firewall inside the engine compartment
- Panel of fuses – on the right-hand side of the instrument panel
- Engine instrument FLYdat – in the middle of the instrument panel
- Instrument switches – in the middle of the instrument panel below the FLYdat
- COMM (B&K KY 97A) – in the middle of the instrument panel above the FLYdat
- COMM antenna – behind the rear canopy on the fuselage upper skin
- Starter button, Ignition switches, switch box, Master switch – in the middle of the instrument panel near its lower edge (above the throttle and choke levers)
- Position lights – on the wing tips
- Anticollision beacon – on the fin tip
- Landing light – on the lower engine cowling

The electrical system of your airplane depends on engine installed. Refer to the Engine Manual for more details.
See Photos on the next page for some equipment location

Photo Ant. Beacon Power Supply Unit attached to the baggage compartment rear

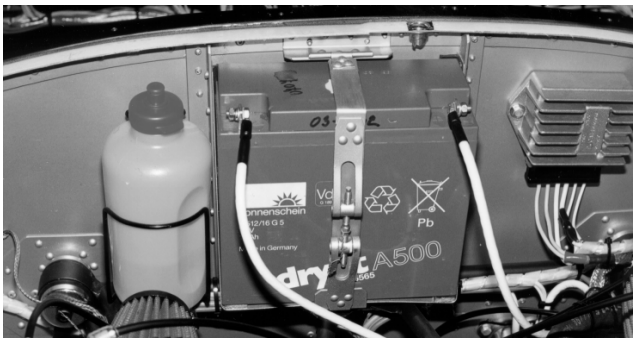


Photo Battery in the bracket attached to the firewall

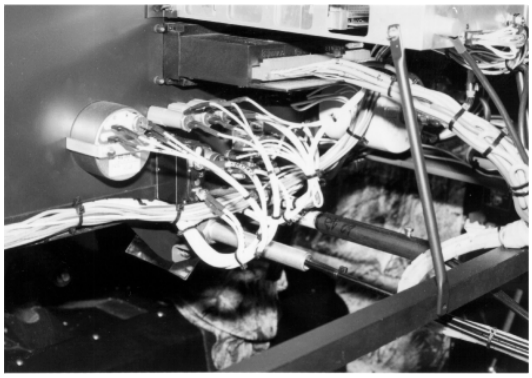


Photo Rear view at COMM/ NAV instruments on the instrument panel

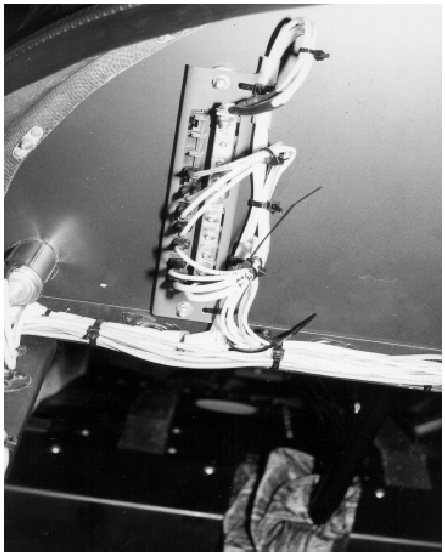


Photo Rear view at box of fuses, bus bar and Socket 12V.

Keep in mind the following if you decide to relocate some instruments or equipment:

- locate the battery as close to the engine starter as possible. This is desirable due to the high electrical draw the starter requires. The battery also must be protected from high temperatures and located in an accessible area for ease of servicing. Weight and balance will also be a consideration. Often a battery will be located in the aft portion of a fuselage to balance the aircraft. Be sure to properly vent the battery.
- Circuit breaker/fuse panels should be reached by the pilot during flight. Therefore the location on the instrument panel or on a fuselage side is recommended

3.4.12.2.3 CALCULATE WIRE SIZE AND CIRCUIT BREAKER SIZE

Calculation of wire size will be necessary during the initial building phase. You will want to route electrical wires prior to completing the construction of the wings and fuselage. Proper wire size is critical to a safe electrical system. The match between the wire size and circuit breaker/fuse size is also critical. To determine the size of wire you will need, refer to FAA Advisory Circular 43-13. The wire size is based upon the amount of current the wire will carry and the length of the wire.

3.4.12.2.4 CONNECT EQUIPMENT TO POWER SOURCE

Fig. Crimping tool

Care should be taken to properly connect all equipment to the power source. Most electrical problems encountered during the initial installation phase can be traced to a poor connection. Crimp on connectors must be carefully installed on a wire that has been properly cut. Cut about 5 mm (3/16-inch) of insulation away from the wire. Use a good quality crimping tool (see figure above). The correct size connector should be used. The connectors are color-coded for a gauge wire. Taking your time as you crimp each connector will save you hours of troubleshooting when you power up your system for the first time. Check the connection physically by pulling on the wire and connector. Protect the connection with the use of heat shrinkable tubing. This tubing will insulate the connection protecting it from electrical faults. Check each connection electrically using an ohmmeter. Equally as important are solder connections. Proper soldering techniques must be used. Practice your soldering before you attempt it on your aircraft.

Fig. Coax crimping tool

Routing of wires is also very important. After marking the wires you can group them into bundles. This is often very convenient when running several wires from one area to the bus bars. Several acceptable practices for routing of wire follows:

- Support wires and bundles of wires using cushioned clamps.
- Do not allow bundles to have too much slack. Using normal hand pressure you should not be able to deflect the bundle more than 15 mm (one-half inch.)

- Separate wires and bundles from flammable fluid lines. If this is not practical, always run the fluid lines below the wire bundle and separate the two by 6 inches or more.
- Protect wires in high temperature areas by using insulating sleeves.
- When running bundles or wires through cutout areas such as bulkheads, protect from chafing by using a rubber grommet.
- Splicing of wire is permitted but should only be used if necessary.
- No more than one splice per connection is recommended.
- The splice should not be within 300 mm (12 inches) of a terminal end.
- Be sure wires are at least 3 inches from control cables. If not possible, use a guard to prevent contact.

Proper routing of cables is necessary to prevent the wires from coming in contact with other parts of the airplane. This can easily occur as a result of movement or vibration. A wire can obstruct movement of a control or it can be damaged causing a short. A shorted wire can be very difficult to locate. This is one other reason to be very careful during the entire installation process.

3.4.12.2.5 GROUNDING AND BONDING

Grounding is defined as the electrical connection of a conducting object to the primary structure to provide a return path for the electrical current. Bonding is the electrical connecting of two or more conducting objects not otherwise connected. The difference between the two can be confusing. A simple explanation is that bonding may not always result in a ground. It may only connect objects. Metal aircraft have a built in ground - the airframe. The main frame of a metal aircraft can be used as a ground. Many builders will use a grounding strap and connect the piece of equipment to be grounded to the frame itself.

The wire used for grounding must be adequate to carry the electrical load. A braided grounding strap is often used. You should also check each grounding connection with an ohmmeter. To be sure you have a good connection between two metal parts the surfaces must be completely clean. Any protective coating should be removed. This can be accomplished by sanding the surface. After the bonding connection is completed, the area can be protected using a varnish.

3.4.12.2.6 INSTALL INSTRUMENTS TO MONITOR THE SYSTEM

You want to know the status of your electrical system as you operate your aircraft. Proper instrumentation can alert you of actual or potential problems. E.g. the V-A meter is installed. The ammeter indicates the amount of current flowing into or out of your battery. The instrument you install should show both charging and discharging current. You can then interpret the condition of your battery and its charging system with this instrument. After 1 hour of flying a typical battery should reach a fully charged state. The indication of this would be a slight indication on the positive side of the ammeter. The ammeter may be used to detect a number of problems. Be sure to install this instrument.
The Voltmeter will monitor the electrical system voltage. For instance, a very low reading could mean that the battery is failing.

We recommend you to install warning lights to monitor the electrical system. The FLYdat, Charging, and Network warning lights are installed on the EV-97 EUROSTAR MODEL 2000 VERSION Rinstrument board in standard.

3.4.12.2.7 COMPLETE A SCHEMATIC DIAGRAM

The schematic diagram is a "road map" of the electrical system. The symbols used in electrical diagrams vary from one manufacturer to another. Some of the symbols are fairly universal but you still may find differences. These symbols are actually a language of electrical components and are shown in technical literature. Mapping out your airplane's electrical system allows you to trouble shoot electrical problems during installation and at a later time when you may encounter a problem. Use as many common symbols as possible so that when another person tries to find a problem at a later date they will be successful.

Refer to the Standard wiring scheme enclosed in Appendices of this Assembly Manual to see an example of schematic diagram used by EV-97 Manufacturer electricians.

3.4.12.3 Additional information

FAR Part 23, that regulates the airworthiness of production aircraft, states that essential elements must be powered by the battery for a minimum of 30 minutes. This is the necessary period of time you need to land your airplane in case of el. system failure; the battery then supplies the essential equipment.

We recommend you to install a maintenanceless gel-cell battery (we install Sonnenschein A512/16G5, 12V/16Ah . This is a lead acid battery that has a material added to the electrolyte converting it into a gel state. This type of battery is less likely to spill and is often used in acrobatic aircraft.

3.4.12.4 Recommended Reading

AC No.43.13-1A

AC No.43.13-1A

3.4.13 Fabricate the Rib

The following is an example of rib processing

3.4.13.1 Introduction

The objective of this Assembly Manual is not only to provide you with EV97 EUROSTAR kit assembly sequences, but also make you familiar with basic technology used in the aircraft industry.
By reason of that we have included in this Manual also the description of processing of some parts, although those parts are supplied in the kit already pre-formed or completed. The wing nose rib is an example.

3.4.13.2 Processing outlines

1. Fabricate the rib template from a zinc sheet
2. Fabricate wooden mold and the strap plate
3. Fabricate dimpling tools
4. Fabricate the rib

3.4.13.3 Necessary material

1. Zinc sheet, thickness 0.6 mm
2. Heard wood board, thickness 23-25 mm
3. Steel bar, diameter 6mm
4. Duralumin sheet to fabricate the rib – ALCLAD 2024, thickness 0.5 mm
5. Sand paper, grit 40, 100, 150
6. Degreaser, detergent, primer

3.4.13.4 Processing equipment, instruments, and tools

1. Pencil
2. Fine tip marker
3. Scriber
4. Try square
5. Compass or marking gauge
6. Center punch
7. Files
8. Rasps
9. Wooden mallet
10. Sheet metal snips
11. Electric hand drill machine
12. Frame saw
13. Drill bits diam. 2/ 4 / 5.9/ 6.1
14. Rotary file
15. Bench vice
16. Grinding machine
17. Wood-turning lathe
18. Band saw (not necessary)

3.4.13.5 Detailed processing sequence

1. Fabricate the rib template from a zinc sheet

STEP 1

Rib outline template

Draw the nose rib outline on the zinc sheet pursuant to the drawing (figure below). The rib outline must be reduced of the sheet thickness i.e. 0.5 mm.

Mark centers of two holes diam. 6.1 mm and centers of lightening holes diam. 90 and 100 mm. Drill all the marked holes using the drill bit of 2 mm. Cut the template by means of a sheet metal snips and file. Deburr edges.

FIG. Rib

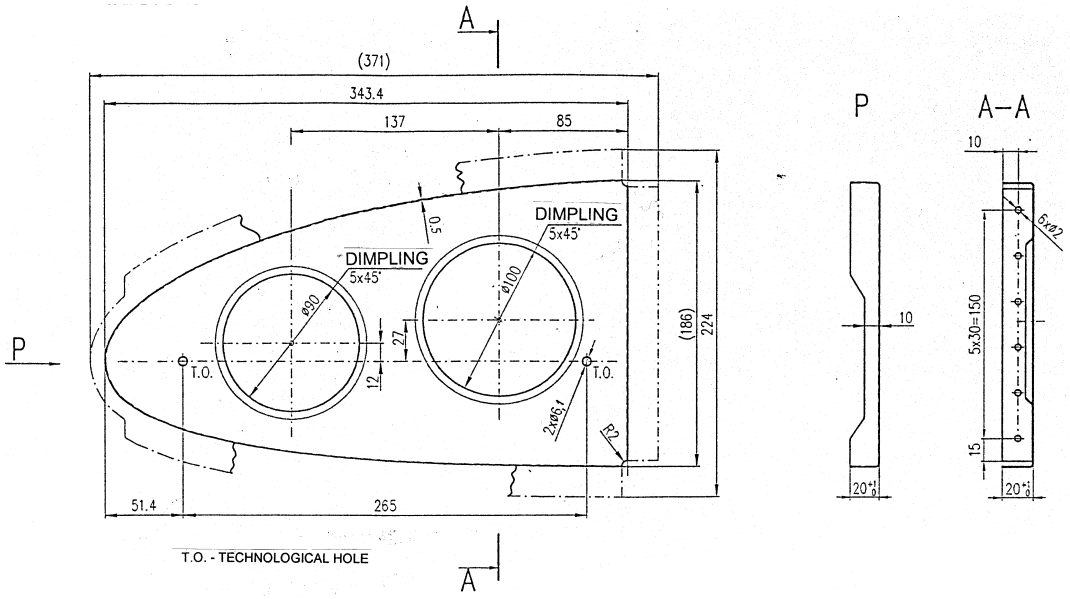
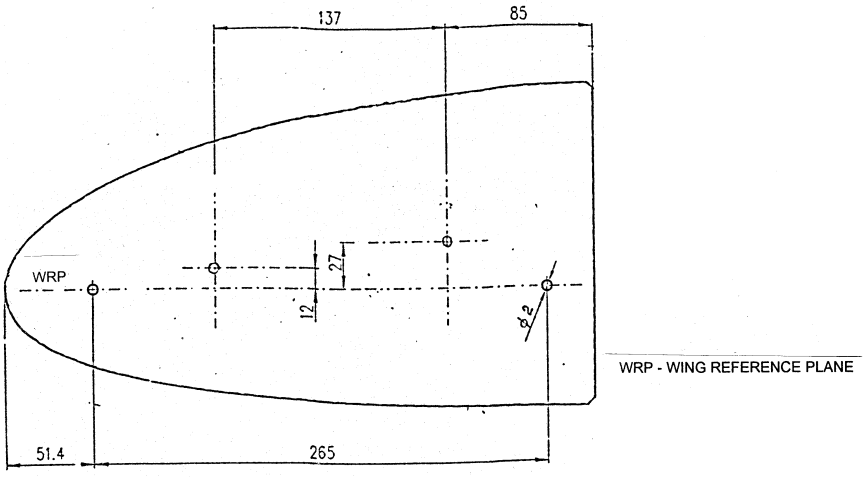


FIG. Rib Outline Template



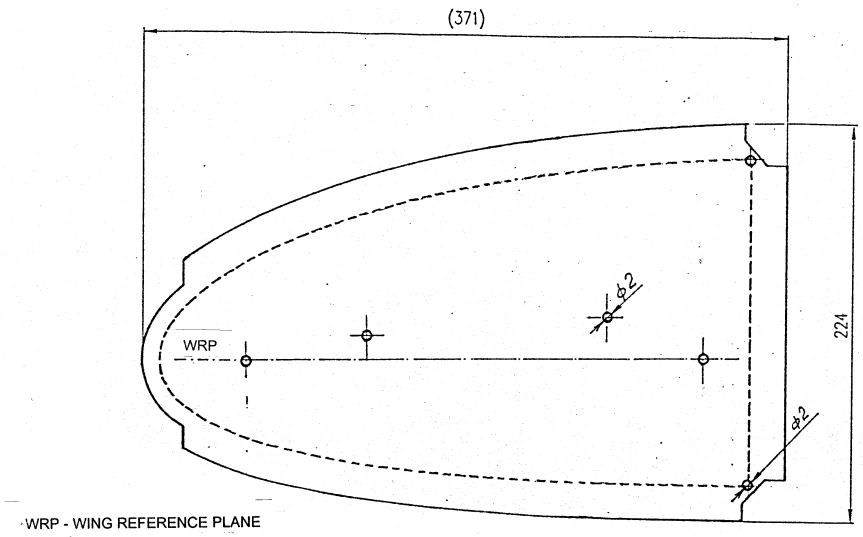
STEP 2

Rib developed shape template

Place the Rib outline template on the zinc sheet and mark with scriber the rib outline and punch also centers of four holes. Add 20 mm width strip along the outline for the rib flanges (see figure below for the allowance on the rib nose).

Mark not only the rib developed shape, but punch also the centers of two holes of 4 mm diameter. Drill all the holes with 2 mm diam. drill bit. Fabricate the template by means of the sheet metal snips and files; if necessary leave the material at the corners to keep the holes of 4 mm diameter. Deburr edges.

FIG. Rib Developed Shape Template



2. Fabricate wooden mold and the strap plate

STEP 1

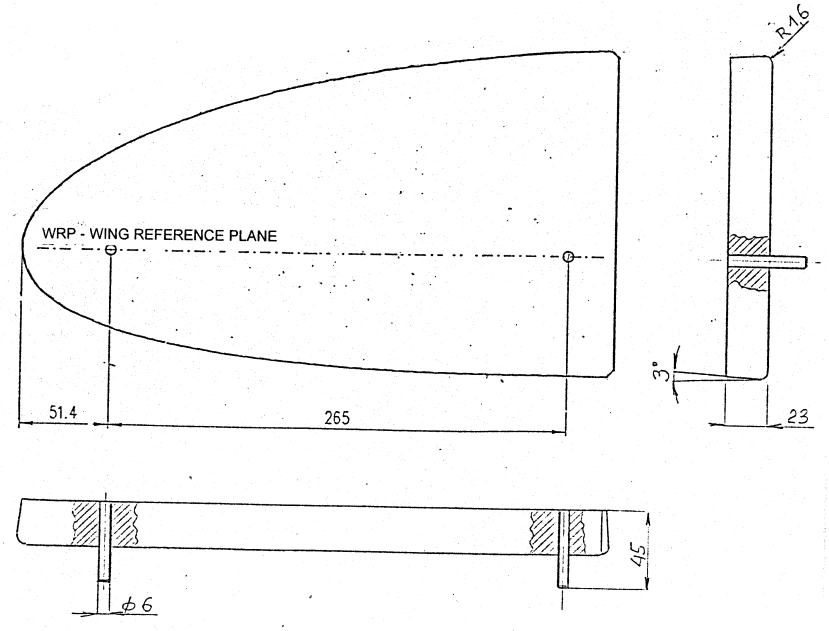
Wooden mold

Place the Rib outline template on a cleared heard board, draw the rib outline and mark centers of holes. Saw the wooden mold rough outline. Vice the mold and file it at required (marked) outline be means of a rasp, file and sand paper. Refer to the figure below for bevel 3 °. Round off the upper edges at 1.6 mm radius and bevel the corners at 2x45 ° - see figure.

Drill two holes 5.9 mm diameter for pins.

Fabricate the pins from the steel bar of 6 mm diameter, cut two pieces of 30 mm length, chamfer the edges by means of a file or grinding machine. Drive the pins into the holes drilled through the mold.

FIG. Wooden Mold

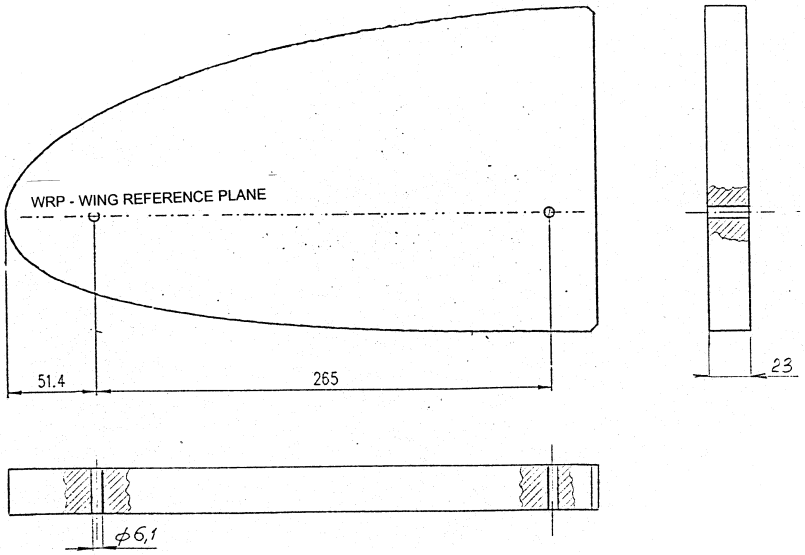


STEP 2

Strap plate

Follow the procedure described above to fabricate the Strap plate. Unlike the wooden mold, the strap plate has not the bevel 3 °, rounding off 1.6 mm, edges are not chamfered, and holes are of 6.1 mm diameter.

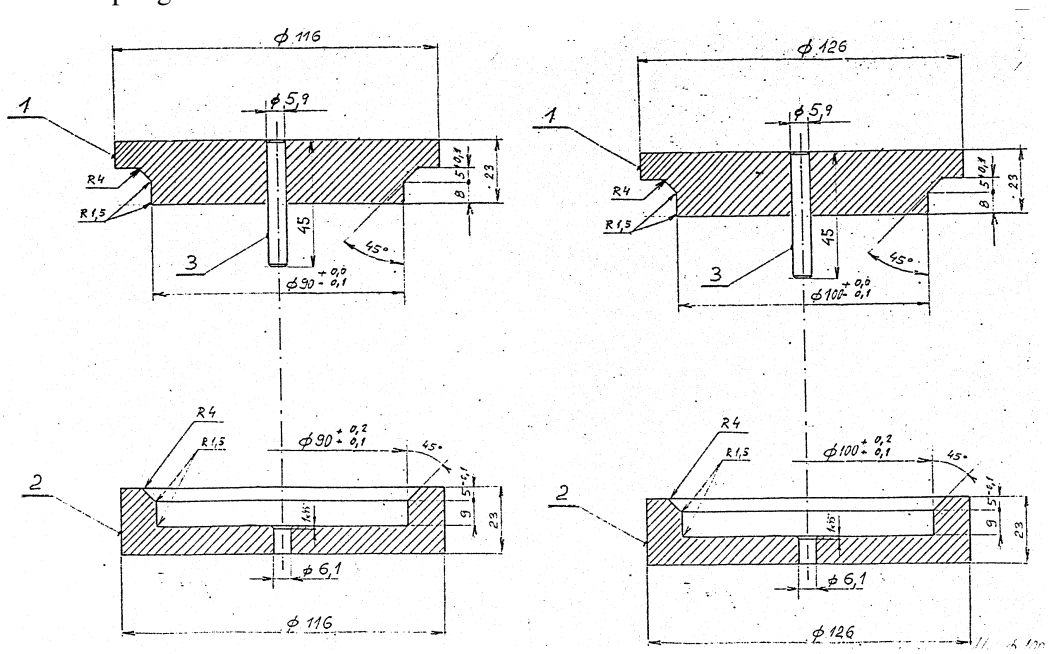
FIG. Strap Plate



3. Fabricate dimpling tools

Each dimpling tool for lightening holes consist of male and female part. Turn both parts of the dimpling tool according to the drawing (figure below) by means of the Wood-turning lathe. Grind with sand paper. Drill hole of 5.9 mm diameter through the male part and 6.1 mm through the female one. Cut the piece of 45 mm length from the steel bar of 6 mm diameter, chamfer the edges and drive this pin into the dimpling tool male.

FIG. Dimpling Tools



4. Fabricate the rib

STEP 1

Preparing the rib developed shape

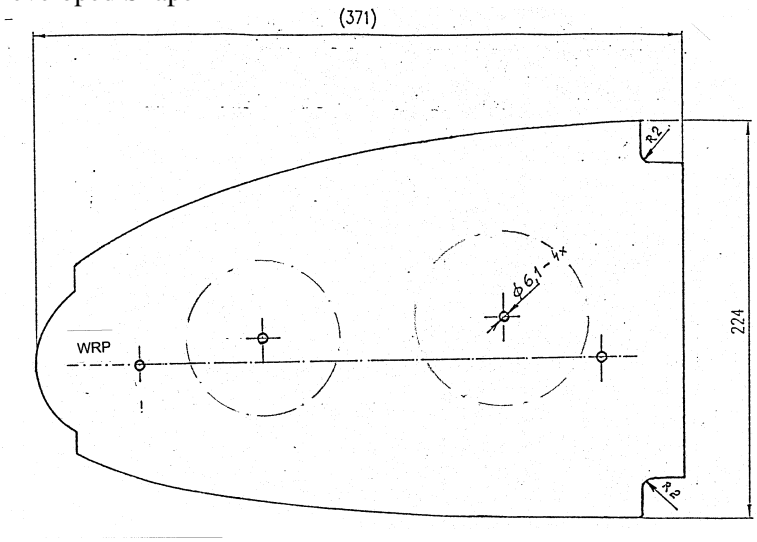
Cut the rectangular of 224x371 mm dimensions from the ALCLAD sheet of 0.5 mm thickness.

Place the Developed rib shape template on the cut rectangular and mark the rib developed shape with a scriber, mark also lightening holes of 90 and 100 mm diameter and punch centers of all holes.

CAUTION

Those marks, which remain on the rib should be marked by a pencil, i.e. not by a scriber.
Cut file and grind the rib at required developed shape, deburr.

FIG. Rib Developed Shape



STEP 2

Forming the rib

Put the rib on the pins of the wooden mold. Then put the strap plate on the rib and vice this assembly. Form the rib flanges by means of a wooden mallet and Vee block so that the flanges bear on the mold.

CAUTION

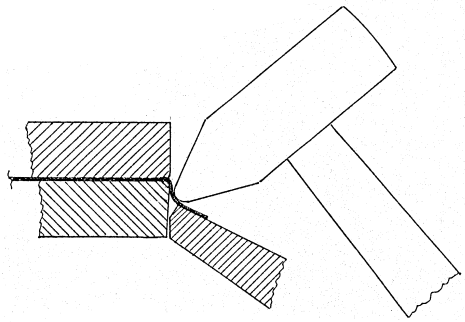
Form the rib flanges gradually along the rib periphery to avoid buckling, i.e. do not hammer at a place to completely form the flange at that place and then at another. The wooden mold bevel of 3 ° eliminates the sheet springing back.

When the flanges are formed, remove the rib from the mold and check if the formed flanges are perpendicular to the rib web, correct if necessary.

CAUTION

Do not form the flanges using a metal tip hammer, use a wooden mallet or plastic tip hammer, only.

FIG. Forming Rib Flanges

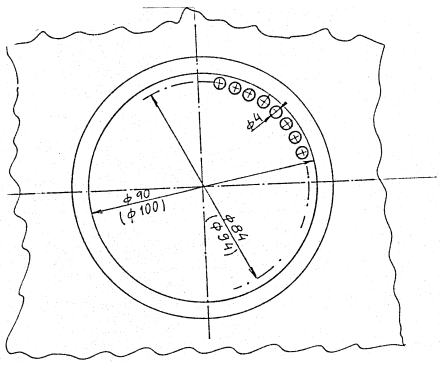


STEP 3

Dimpling

Put the rib on the centering pin of the male part of the dimpling tool, set the opposite female part and vice (or use a hand press) to form the lightening hole (90 mm diam. and then 100 mm, also). Mark the hole circle and drill a series of close holes of 4 mm diameter to remove the lightening hole inside. File the edges at required diameter of lightening hole by means of a rotary file. Deburr.

FIG. Cutting Lightening Holes

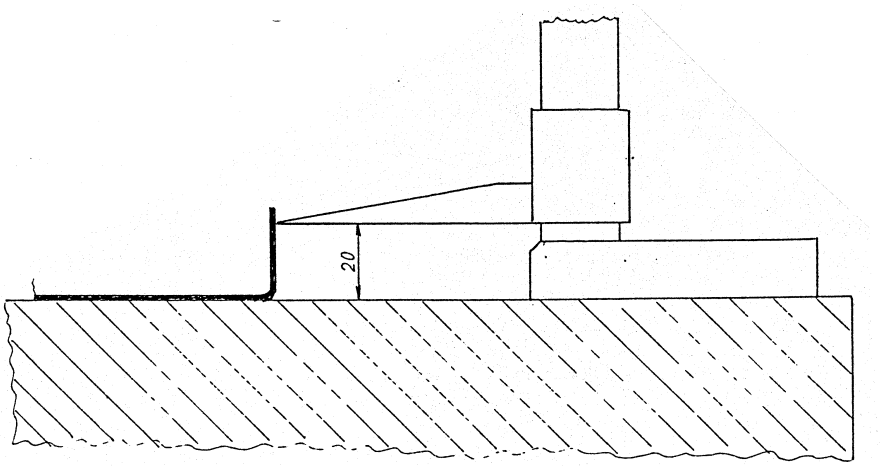


STEP 4

Cutting the rib flanges

Place the rib on a flat workbench, load with a weight and mark the width of rib flanges (20 mm) by means of a marking pen mounted in a compass (set the distance between the legs of the compass equal to the widtch of flanges) or by marking gauge (see figure below). Cut the flanges at required width by means of a Sheet metal snips, file and deburr.

FIG. Marking the Rib Flange Width

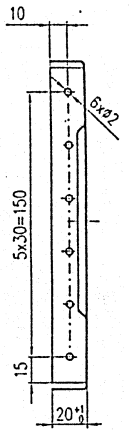


STEP 5

Drilling the rivet holes through the rib flange

Mark the rivet center line on the rib flanges according to the drawing (figure below), then drill holes of 6 mmm diameter and deburr.

FIG. Rivet Holes



STEP 6

Rib surface protection

Degrease the rib from impurities, then wash with hot water with a detergent and dry. Apply a primer on the rib surface by means of a spray gun.

3.4.14 Aircraft Painting

3.4.14.1 General Information

To exhaustively cover the entire subject of finishing and painting an airplane would almost double the size of the EUROSTAR Assembly Manual, so we'll provide only some general guidance here. For additional information, refer to the publications listed in 2.7 Recommended Reading. Probably the best sources of information for painting and finishing procedures are the paint manufacturers' own published guidelines for the use of their products..

The interior structure of airframe is not necessary to paint (if you do not need an extra protection) because all of the airplane's metal skins are Alclad aluminum and steel parts zinc plated. So you will probably paint only the cockpit interior.

All the exterior surfaces of airplane should be painted with a primed and finish paint.

The next issue to consider is whether you want to paint it yourself. We recommend completing most of the surface preparation yourself and letting a professional apply the conversion coating (if used) for metal parts, the primer and the finish paint. A good professional painter has a climate-controlled work area to achieve the best finish and also has experience with different types of paint to avoid problems (such as "orange peel," "blushing," "fish eyes" or paint runs) that a novice might encounter.

Letting a professional apply the paint also saves the price of a spray gun, reduces your exposure to hazardous chemicals and eliminates the problem of dealing with overspray in your home workshop environment. If you choose this route, consult with the painter before beginning surface preparation to both clarify what is expected in terms of surface preparation and to ensure that the solvents and primer you use will be compatible with the finish paint..

CAUTION

The weight of the EV-97 airplane will increase about 6-7 kg, 13-14 lbs (depends on colors used for painting, color scheme and layer thickness) and Center of gravity moves about 2.5 % MAC to the rear.

In general a white color, or at least a very light color, with a minimum of dark color trim is recommended for finish paint. Light colors, especially white, absorb less solar energy and keep the painted surfaces as cool as possible.

We recommend to paint an area of the upper skin in front of the cockpit canopy with a matte black color to avoid sun glare caused by reflected sunlights.

3.4.14.2 Preparing Parts for Painting

3.4.14.2.1 Preparing Sheet Aluminum Parts for Painting

The steps to prepare sheet aluminum parts for painting are essentially the same as the steps for "Corrosion Protection" discussed previously: cleaning, sanding and/or etching and priming. Cleaning involves using a suitable solvent or a detergent solution to remove oils and other contaminants from the surfaces of the parts. The parts are then wetsanded with 400 grit paper and/or etched with some kind of conversion coating or acid etching process. Finally, a suitable primer is applied. Refer to the " section for a further discussion of these steps.

Before you can begin this process, however, you will have to choose the type and brand of paint you are going to apply. The most common paints for aluminum airplanes are acrylic enamels and lacquers, and polyurethane enamel. Consult with your paint professional to choose a paint system, then follow the paint manufacturer's recommendations for preparation. Remember that it is always best to stick to the same brand for primers, thinners, top coat and other chemicals. While two different manufacturers might specify the same type of thinner, for example, compatibility is not guaranteed unless you use each manufacturer's own products exclusively.

3.4.14.2.2 Preparing Fiberglass Parts for Painting

To prepare fiberglass parts for painting you should first clean them, than degrease and fill up the surface (using a rapid hardening polyester stopper etc.). When the stopper is hardened wetsand and degrease the filled surface, again.

Use acrylic or polyurethane colors to paint the fiberglass parts or consult with your paint professional to choose a paint system and then follow the color manufacturer´s instructions.

The colors must not etch the fiberglass structure.

The interior surface of engine cowlings must be protected with fireproof paint.

3.4.14.2.3 Surface Filling

We recommend you to fill up and wetsand the following parts prior to painting the airplane:

- Blind rivet heads – dimple causes by a river mandrel shearing
- Transitions between the fiberglass parts and the skins
- Roughness of fiberglass parts
- Some other surface imperfections

A suitable rapid hardening polyester stopper is recommended. After hardening wetsand the surface filled up.

3.4.14.3 Applicable Brands of Colors

To date, the most popular primer choices have been either the traditional zinc chromate or epoxy. Both provide good corrosion protection, although epoxy is somewhat superior and is clearly preferable for airplanes that will be exposed to salt water or spray. The downside of epoxy for other applications is the inconvenience of having to measure and mix the resin and the hardener. For its part, zinc chromate is even more highly toxic than epoxy is, and its use is declining for that reason. The new water-based primers appearing on the market are safer environmentally, but be sure to check with the manufacturer about the corrosion-protection service history of a new product..

CAUTION

Both the solvents used for pre-primer cleaner and the most popular primers themselves are powerful and potentially harmful chemicals. Follow all manufacturers' safety guidelines carefully. Good ventilation is absolutely essential, and the use of rubber gloves, goggles and a respirator is highly recommended.

3.4.14.4 Painting

After you are satisfied with the filling and sanding phase of surface preparation, you are ready for the final finish coats of primer and paint. Use an air nozzle to blow out any dust that may have accumulated in cracks and crevices throughout the fuselage. If you don't do this now, the air from the paint spray gun will raise the dust during final paint spraying, to the detriment of the airplane's final finish. Also, thoroughly vacuum the entire surface and, if you are doing your own painting, use a solvent compatible with the finish to wipe down the surfaces to be painted. Besides helping to remove dust, the solvent removes fingerprint oils and other surface contaminants that might interfere with good paint adhesion.

As a final step immediately before painting, use a tack cloth to remove dust from the airframe surfaces.

Some general considerations are applied for the painting: rather paint two thin layers than the one thicker, next layer paint after hardening of previous etc. If you are not familiar with this, contact a professional painter or read specialized publications.

4. ASSEMBLY SEQUENCES

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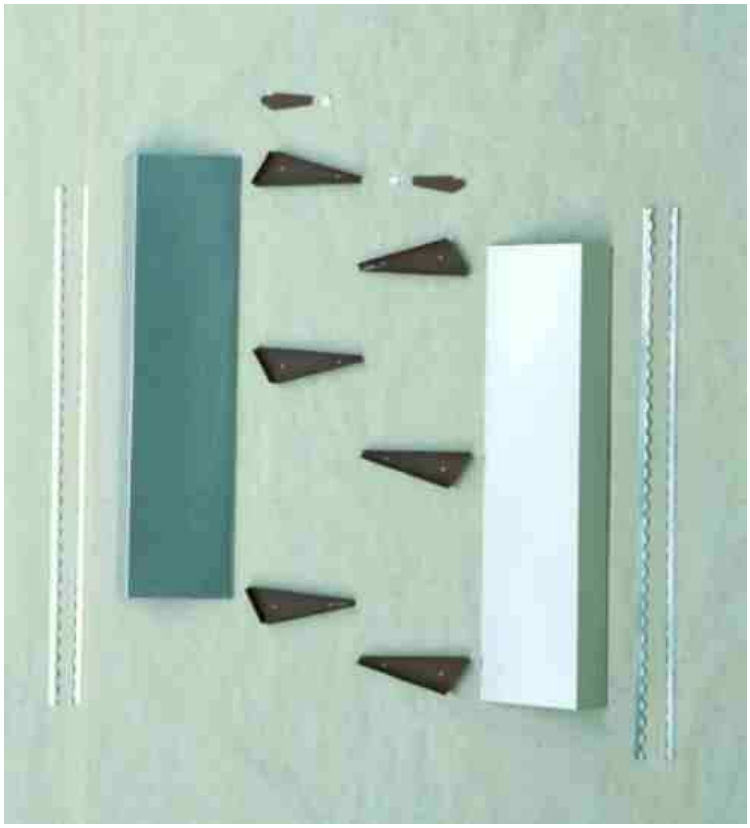
5. AILERON

5.1 Illustration



5.2 Parts List

See pages at the end of this Section

5.3 Workspace

A common workbench

5.4 List of Drawings

E2 50-51 01/02 Aileron LH, RH

5.5 Required Tools and Instruments List

No.	Tool	Pieces
1.	Electric hand drill	1
2.	Drill bit diam. 2.5 mm	1
3.	Drill bit diam. 3.3 mm	1
4.	Clecos diam. 2.4 mm	8
5.	Try square	1
6.	Rule 300 mm	1
7.	Metal sheet snips	1
8.	Emfimastic Hand gun	1
9.	EMFIMASTIC PU 50 sealant	1
10.	Sand bags (5 kg, 10 lbs)	2
11.	Fine tip marker	

5.6 Assembly Outline

1. Riveting Ribs

2. Riveting Hinge

3. Riveting Lever

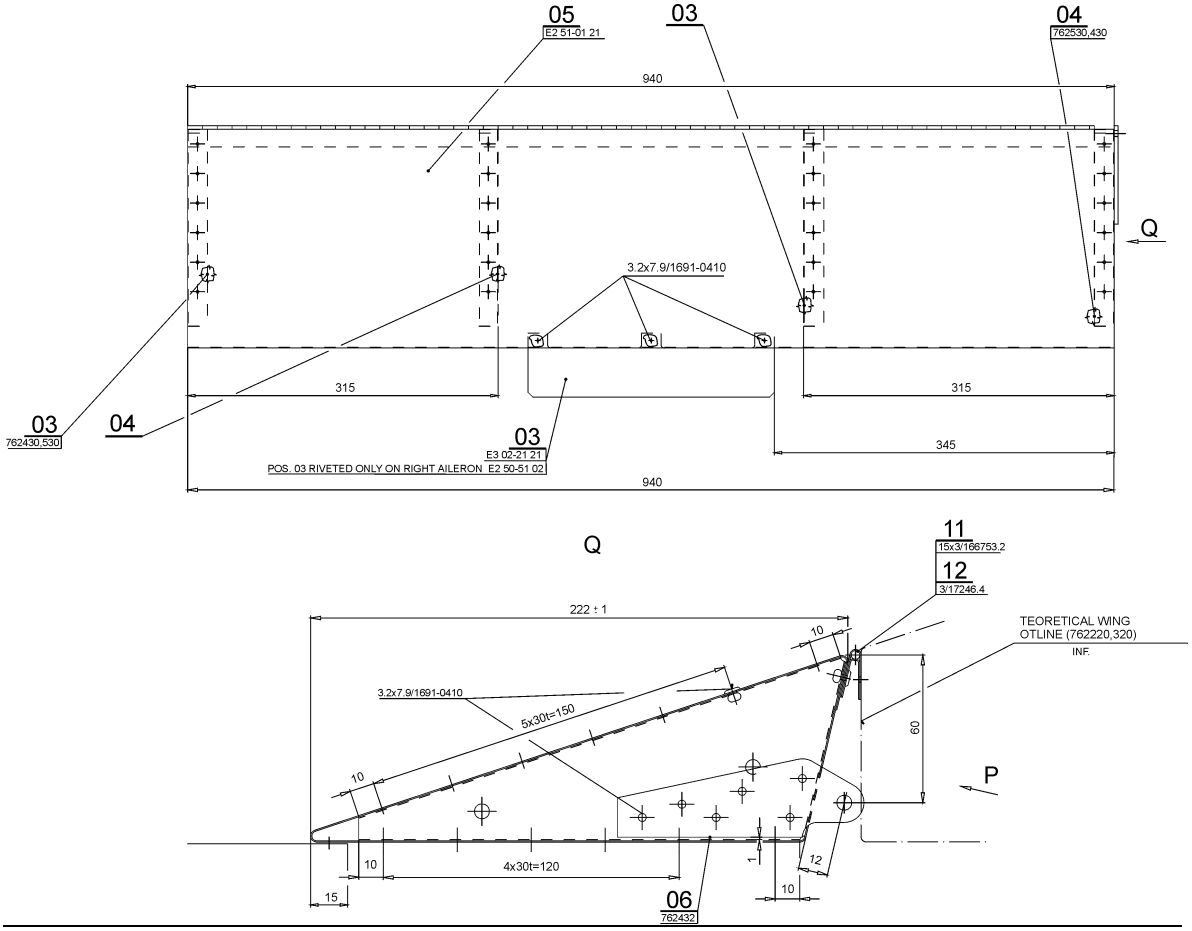
5.7 Detailed Assembly Sequence

1. Riveting Ribs

Mark the flange centerlines on the ribs No.3 and No.4. Measure and mark rivet line positions and rivet spacing on the upper and lower surface of the aileron skin Pos.5 – see Figure below. Pre-drill rivet holes (resp. holes for Clecos) through the aileron skin using drill bit diam. 2.5 mm.

CAUTION

Do not drill rivet holes through the aileron front and in place of aileron hinge.



Completed: [ ]

STEP 2

Insert the middle ribs into the aileron skin Pos.5. Align the ribs position so that the lines marked on the rib flange are visible through the pre-drilled holes in the skin. Drill holes diam. 2.5 mm through the upper aileron skin and the lower one at both ends of the middle rib. Insert Cleco into each of these holes to "tack" the skin and middle rib together and maintain alignment between them. Then go back and drill intervening holes and cleco as you go. Follow the same procedure to position, align and cleco aileron root and tip rib.

CAUTION

Do not drill rivet holes through the aileron front and in place of aileron hinge.

Completed: [ ]

STEP 3

Dissasemble, clean and deburr all the aileron parts. Apply EMFIMASTIC sealant on the upper and lower flanges of the ribs. Reassemble the aileron using Clecos. Step by step take the Clecos out of the aileron lower skin, redrill holes at 3.3 mm diam. (clean the drill bit shank polluted with sealant and chips using a thinner) and rivet the lower skin to the ribs using blind rivets 3.2x7.9 mm. Place the aileron lower surface on a flat workbench and load the upper skin with sand bags (put a suitable board under the bags). Step by step take the Clecos out of the aileron upper skin, redrill holes at 3.3 mm diam. and rivet the upper skin to the ribs using blind rivets 3.2x7.9 mm.

Completed: [ ]

STEP 4

With the upper skin still loaded, drill holes diam. 3.3 mm through the aileron front.

CAUTION

Do not drill rivet holes in place of aileron hinge.

Gently lift up the skin in the front, clean as possible, apply EMFIMASTIC on the rib front flanges and then rivet the skin to the aileron front with blind rivets.

Completed: [ ]

2. Riveting Hinge

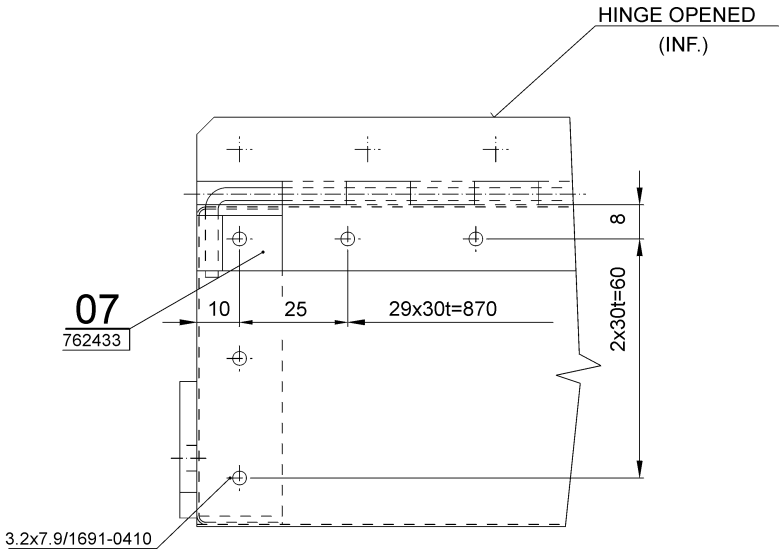
STEP 1

Cut the Hinge Pos.11 at the required length (acc. to the aileron), cut the hinge end for the Stop Pos.7. Measure and mark the rivet line and rivet spacing on the hinge and predrill holes diam. 2.5 mm through the hinge. Position the hinge on the still loaded aileron, drill holes diam. 2.5 mm in place of the aileron ribs and cleco the hinge to the aileron front as you go. Then go bak and drill intervening holes using drill bit diam. 3.3 mm.

Completed: [ ]

STEP 2

Remove the hinge, clean and deburr. Connect both halves of the hinge with the wire. Apply EMFIMASTIC sealant on the hinge half to be riveted to the aileron front. Cleco the hinge back to the still loaded aileron and rivet (between aileron ribs) with blind rivets. The take out the Clecos clamping the hinge to the aileron ribs, redrill holes at 3.3 mm diam. and rivet also. Put the Stop Pos.7 on the hinge wire and rivet the stop to the aileron with the blind rivet.



Completed: [ ]

3. Riveting Lever

STEP 1

Finally position the Aileron Lever Pos.6 on the aileron root rib and drill holes diam. 3.3 mm through the lever and rib. Remove the lever, clean and deburr, apply EMFIMASTIC sealant on the lever, position lever back and rivet with blind rivets.

Completed: [ ]

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6. FLAP

6.1 Illustration

6.2 Parts List

See pages at the end of this Section
Parts are in package No. **XX**

6.3 Workspace

A workbench of length 2.3 m.

6.4 List of Drawings

E2 01-03 01/02 Flaps RH, LH

6.5 Required Tools and Instruments List

No.	Tool	Pieces
1.	Electric hand drill	1
2.	Drill bit diam. 2.5 mm	1
3.	Drill bit diam. 3.3 mm	1
4.	Clecos diam. 2.4 mm	16
5.	Try square	1
6.	Rule 300 mm	1
7.	File	1
8.	Metal sheet snips	1
9.	Emfimastic Hand gun	1
10.	EMFIMASTIC PU 50 sealant	1
11.	Fin tip marker	1

6.6 Assembly Outline

1. Marking Rivet Lines on the Skin

2. Drilling and Riveting Ribs together with the Flap Lower Skin

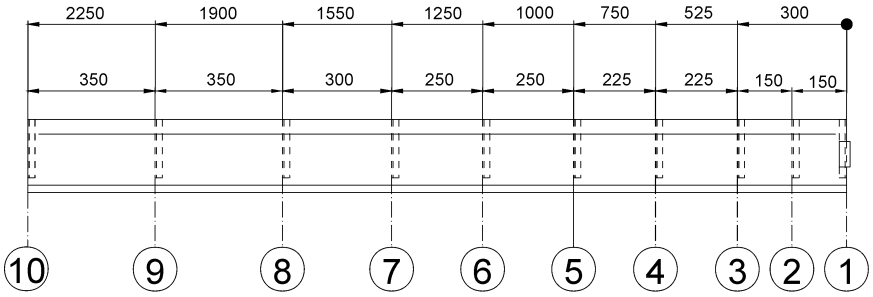
3. Position Hinge and Flap Guide

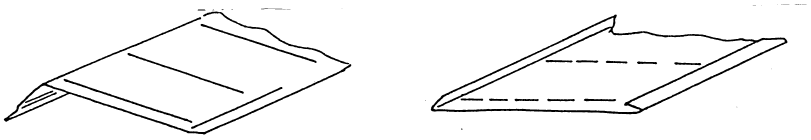
6.7 Detailed Assembly Sequence

1. Marking Rivet Lines on the Skin

STEP 1

Mark the rivet lines on the Flap lower skin Pos.7 and the upper one Pos.1 – see Figures below and keep in mind the rib flanges width.





Completed: [ ]

STEP 2

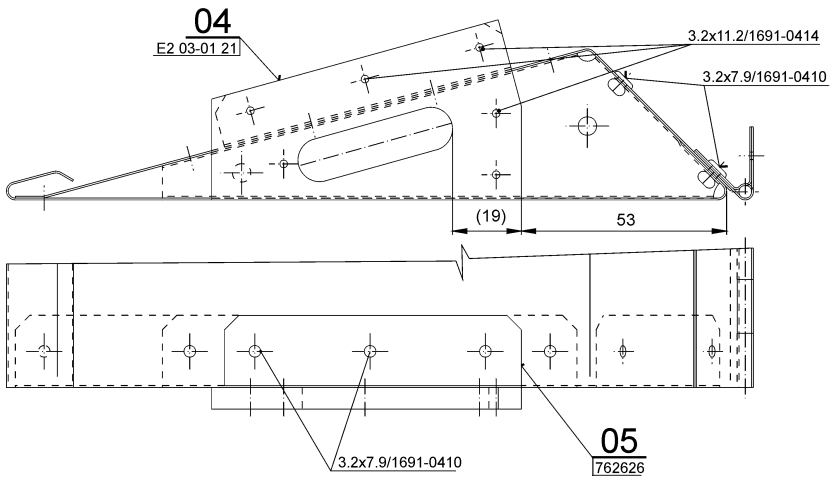
Mark the rivet centerlines on the flanges of rib Pos.2 and Pos.3. Measure and mark rivet spacing on the upper and lower flap skin. Drill rivet holes diam. 2.5 mm through the skins except those for the rib. No.1 on the flap upper skin.

Completed: [ ]

2. Drilling and Riveting Ribs together with the Flap Lower Skin

STEP 1

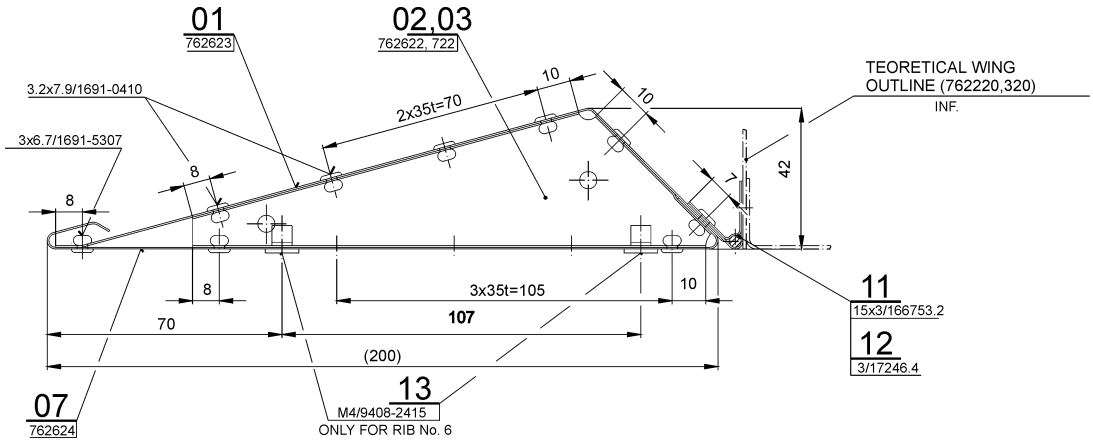
Position the ribs on the flap lower skin using the predrilled holes in the skin as guides for rib flange centerlines. Drill the holes diam. 2.5 mm at the ends of each rib and cleco the ribs to the lower skin. Then go back to drill intervening holes and cleco.
Prior to drilling the flap root rib together with the flap lower skin, position and align the Guide Pos.4 on the flap root rib, drill rivet holes diam. 2.5 mm through the guide and rib, cleco and file the oval hole in the root rib according to the hole in the guide. The remove the guide. Dissasemble, clean and deburr. Apply EMFIMASTIC sealant on the lower flanges of the ribs and reassemble the ribs to the flap lower surface using Clecos. Step by step take out the clecos, redrill hole at 3.3 diam. (clean the drill bit shank polluted with sealant and chips using a thinner) and rivet the ribs together with the flap lower skin.



Completed: [ ]

STEP 2

Position the flap upper skin on the ribs, so that the rib flange centerlines are visible through the holes predrilled in the upper skin, then drill holes diam. 2.5 mm through the ribs and cleco as you go. Then drill and cleco also the flap trailing edge.
Do not forget about the Coupling Pos.5 when drilling the root rib holes.
Disassemble, clean and deburr. Apply EMFIMASTIC selant on the upper flanges of all ribs and also on the trailing edge. Reassemble using Clecos. Place the flap lower surface on a flat workbench and load the upper skin with sand bags (put a suitable board under the bags). Step by step take the Clecos out of the flap upper skin, redrill holes at 3.3 mm diam. (clean the drill bit shank ig necessary), and rivet the upper skin to the ribs with blind rivets. Finally step by step take out Clecos clamping flap trailing edge, redrill hole at diam. 3.3 mm and rivet the flap trailing edge.

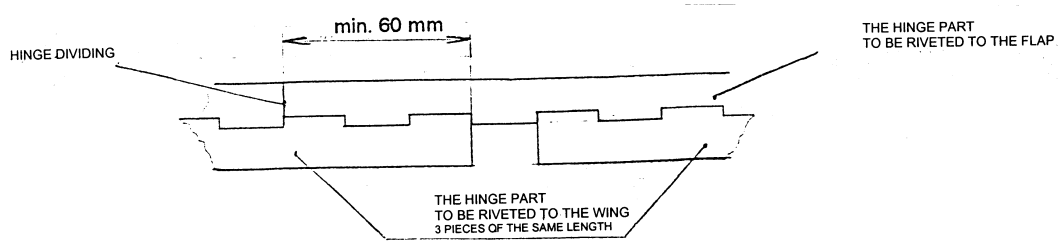


Completed: [ ]

3. Position Hinge and Flap Guide

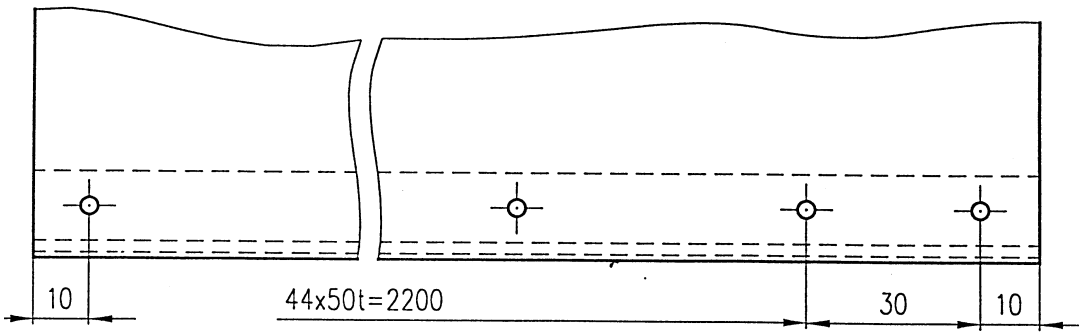
STEP 1

In this Step position the lap Hinge Pos.11.
Since the hinge supplied in the kit is shorter, three pieces of the same length must be used – see Figure below. The hinge should end with a solid not cut link.

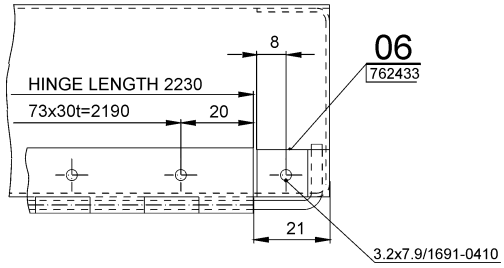


Measure and mark rivet hole centers on the hinge half to be riveted to the flap. The drill the holes diam. 2.5 mm through that half – see the following Figure.

K



Connect both halves of the flap hinge using the wire Pos.12. Load the flap upper surface with sand bags, if the flap is not still loaded, and check the flap not to be twisted.
Position the hinge on the flap front according to the front view K; do not forget that the Stop Pos.6 ends the the hinge and that the hinge lower edge must be aligned with the flap lower skin.
Drill rivet holes diam. 2.5 mm through the hinge positioned on the flap front and cleco as you go. Disassemble, clean and deburr. Apply EMFIMASTIC sealant on the hinge half to be riveted to the flap. Cleco the hinge back to the flap and check again if the flap is not twisted. Step by step take out the Clecos, redrill holes at diam. 3.3 mm and rivet the hinge to the flap with blind rivets. Put the Stop Pos.6 on the wire and rivet the stop to the flap.



Completed: [ ]

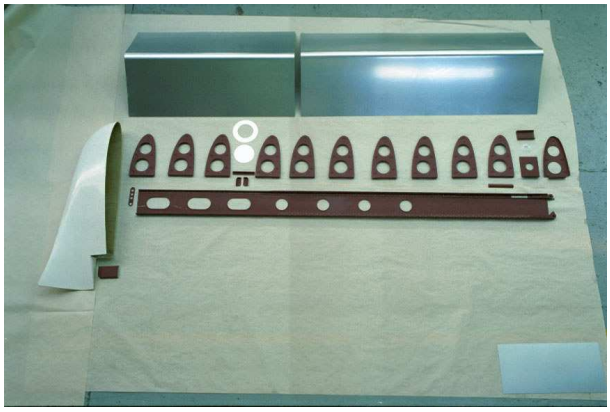
STEP 2

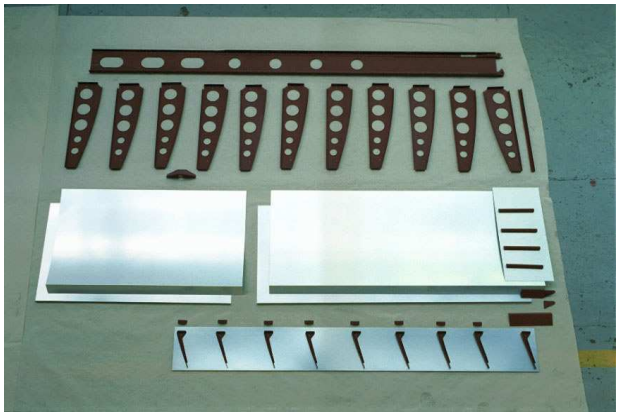
Finally apply EMFIMASTIC sealant on the Guide Pos.4 and Coupling Pos.5, position on the flap root rib, cleco, step by step take out Clecos, redrill holes at diam. 3.3 mm and rivet with blind rivets.

Completed: [ ]

12. WING

12.1 Illustration





12.2 Parts List

See enclosed pages at the end of this section.

12.3 Workspace

Flat work area, preferably worktable dimensions 3000x1200 mm, free accessible and normal work table for detail preparation and tooling.

12.4 List of Drawings

E2 00-50.01

12.5 Required Tools and Instruments List

No.	Item	Pieces
1.	Electric hand drill	1
2.	Drill bit ∅ 2,5 mm	1
3.	Drill bit ∅ 3,3 mm	1
4.	Drill bit ∅ 4,1 mm	1
5.	Drill bit ∅ 8,5 mm	1
6.	Drill bit extended ∅ 2,5 mm	1
7.	Drill bit extended ∅ 3,3 mm	1
8.	Cleco ∅ 2,4	44
9.	Cleco ∅ 3,2	22
10.	Cleco ∅ 4	8
11.	Cleco pliers	1
12.	Try square	1
13.	Steel rule 300 mm	1
14.	Fine tip marker	1
15.	Hand riveter for blind rivets	1
16.	Clamps (locksmith's, welding)	4
17.	Jig to drill ribs together – see below	1
18.	Wooden scanting	1
19.	EMFIMASTIC hand gun	1
20.	Tightening straps	1
21.	Alu tip hammer 200 g	1

12.6 Assembly Outline

1. Riveting ribs at spar

2. Brace and control guidance alignment

3. Lower skin riveting

4. Upper skin riveting

5. Leading edge skin riveting

6. Rear wing hinge riveting

7. Flap assembly

8. Aileron assembly

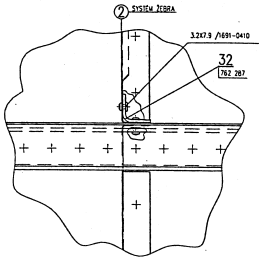
9. Wing tip assembly

12.7 Detailed Assembly Sequence

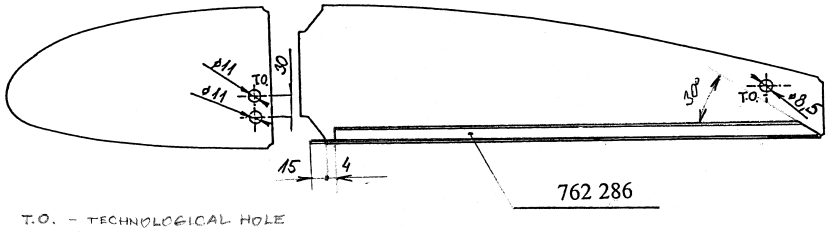
1. Riveting ribs at spar

STEP 1

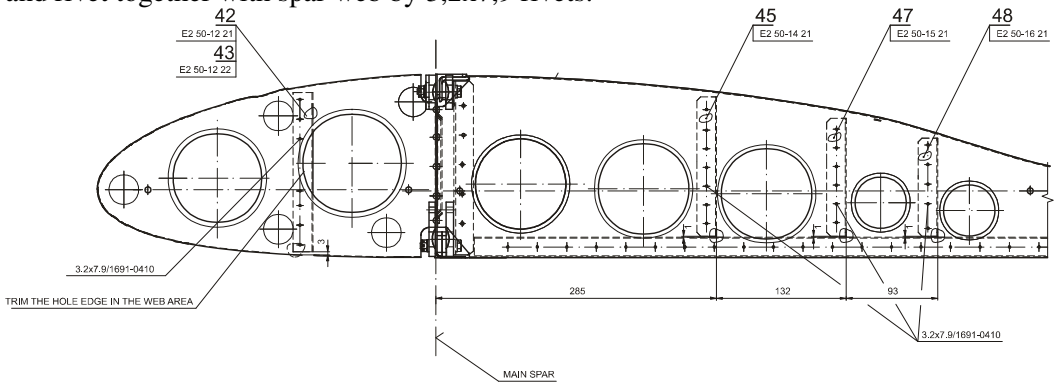
Preparing ribs No. 1 and 2.



Insert reinforcement 762 287 into rib No. 2 flange. Drill together using pre-drilled holes in reinforcement, rivet together by 3,2x7,9 rivets. Second reinforcement flange drill together using holes in rib flange. In the rib No. 2 make cut-out (24, 24) - see Dwg. No. E2 00-50 01 sheet 6, cut C-C. Drill 2 holes ∅ 11 mm in ribs No. 1-8 at left wing for pitot-static system hoses. Insert rubber grommets into holes.



Insert reinforcement No. 762 286 into first rib lower flange, trim conform to sketch. Drill and rivet together with spar web by 3,2x7,9 rivets.



Position webs pos. 42 (43), 45, 47, 48 according to figure to the first rib, drill and rivet together wit rib by 3,2x7,9 rivets.

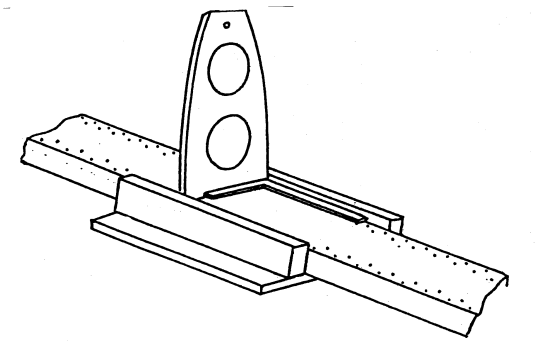
Re-drill all technologic holes in all rear half-ribs at ∅ 8,5 mm, insert rubber grommets. This grommets serve for electric light installation. Mark rib flanges center lines for all ribs.

Completed: [ ]

STEP 2

Measure and mark ribs spacing at both sides of spar conform drawing E2 00-50.01. Using try square and simple jig, mark perpendicular ribs positions. Number rib positions.

Completed: [ ]



STEP 3

Leading edge half-ribs drilling together with spar.

By try square and jig, align rib into proper position. Using rib flange pre-drilled holes, drill two terminating rivet holes at ribs together with spar (not at spar flanges) by extended 2,5mm diameter drill bit. Cleco rib and drill-out remaining holes. Number rib and same procedure drill together remained ribs.

Completed: [ ]

STEP 4

Trailing edge half-ribs drilling together with spar.

Rear ribs (trailing edge ribs) drill together with holes already drilled in spar. Remove always responding leading edge half-rib. Align rear half-rib conform spar marking by try square. Two person is recommended for this work. Assistant keeps rib in proper position, preferably by wooden scanting. Remove all ribs when drilled, re-drill holes at ∅ 3,3 mm, clean and deburr. Do not forget mark ribs numbering.

Completed: [ ]

STEP 5

Ribs riveting.

Step by step rivet ribs, starting from No. 1. Apply EMFIMASTIC sealant at contact surfaces, place rib to the spar, cleco and rivet together. Remove clecos, re-drill clecoed holes, rivet. Use same procedures for all ribs.

Use 3,2x7,9 rivets, only for rib No. 2 use 4x9,5 and 4x16,7 rivets.

Completed: [ ]

2. Brace and control guidance alignment

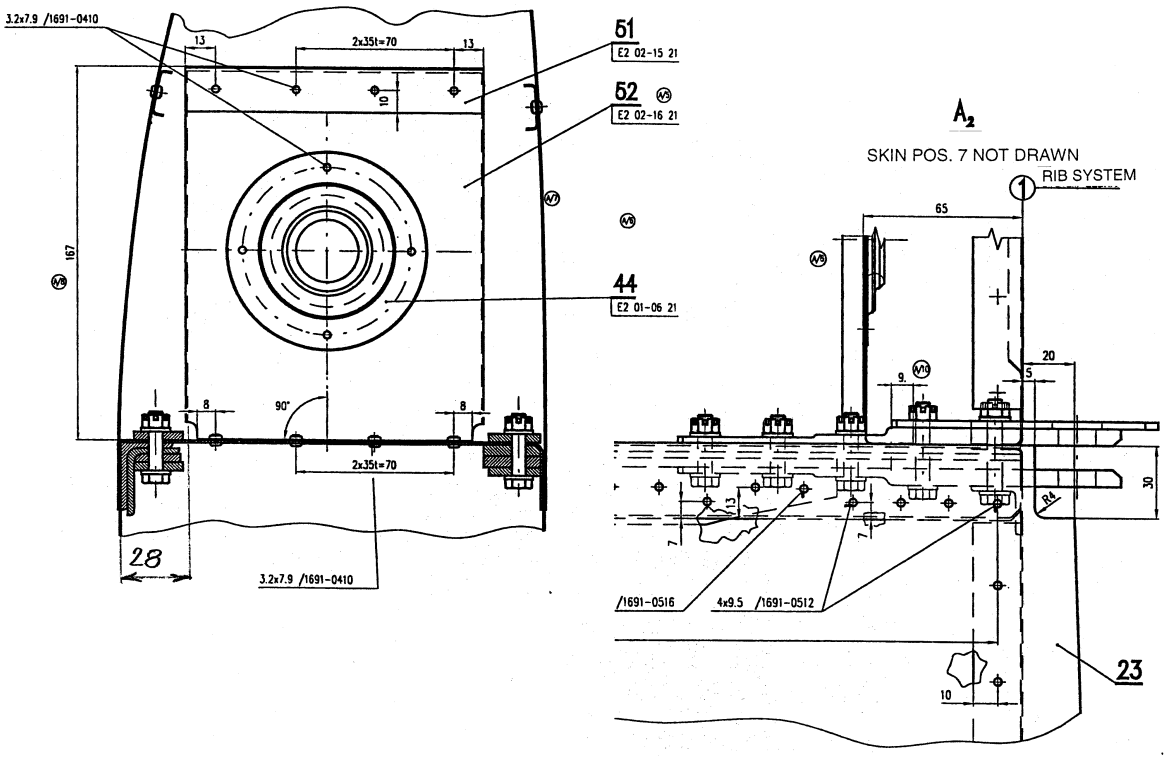
STEP 1

Drill together rear rib No. 1 with reinforcement, fastened by bolts to the hinges, rivet by 3,2x7,9 rivets.

Completed: [ ]

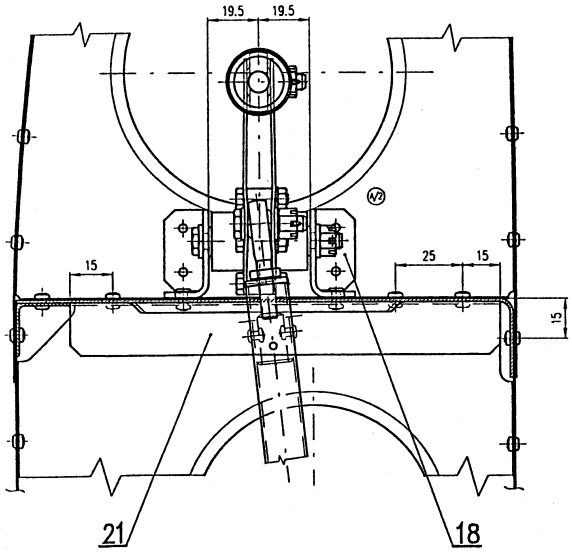
STEP 2

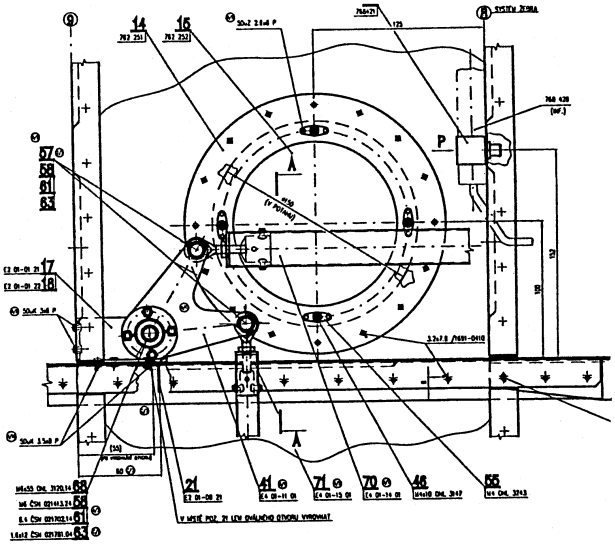
By four 3,2x7,9 rivets rivet together ring E2 01-0621 (pos. 44) with mount E2 01-1621. Align mount at 65 mm distance, measured from rib No.1. Drill together with spar and join them together by clecos. Connect upper mount side with rib No.1 by liner E2 01-1521 (pos. 51) and drill together using already pre-drilled holes. Dismount, apply EMFIMASTIC sealant, cleco, re-drill at ∅ 3,3 mm and rivet by 3,2x7,9 rivets.



Braces pos. 17 and 18 screw together with control lever E4 01-1101 pos. 41.

Put assembly in front of spar and rib No. 9, mark holes, drill together ∅ 2,5 mm, cleco, re-drill at ∅ 4,1 mm.





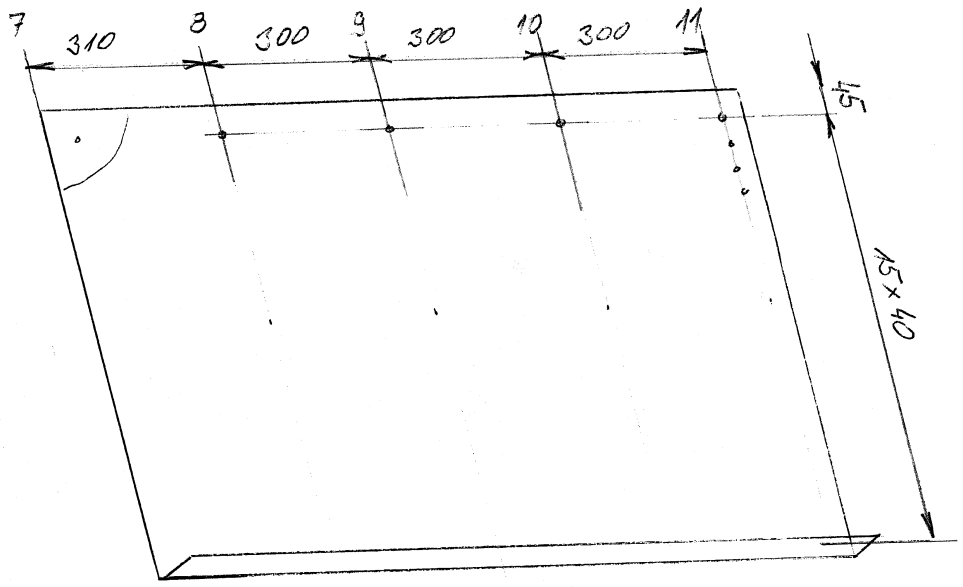
Prior braces riveting together, dab off by Alu. tipped hammer spar strut flange and underlay by reinforcement E2 01-08 21 pos. 21.
Dismount all parts, apply EMFIMASTIC sealant at contact surfaces, cleco reinforcement pos. 21 in terminated holes, rivet braces together with spar by 4x9,7 rivets. There are used 3,2x7,9 rivets out of braces.

Completed: [ ]

3. Lower skin riveting

STEP 1

Start by outer skin between ribs 7 and 11. Check skin proper position and measure rivet holes for ribs No. 8 – 11. Rib No.7 will be drilled together with inner skin. Drill all holes at ∅ 2,5 mm.



Completed: [ ]

STEP 2

Place skin at wing frame to match rib No. 7 edge. Rear rib flange No. 11 and 7 fasten to skin flange to see rib flange central line through holes in skin flange. Through holes in skin align rib No.8, drill together terminated holes, cleco them. Drill together remaining holes. Use same procedure for ribs No. 9, 10 and 11. Re-drill holes at ∅ 3,3 mm. Dismount all parts, clean and deburr.

CAUTION
Pay attention to ribs No. 8 and No. 9! Don't drill holes for rivets in the area of the semicircular stiffener pos. 39 and the stiffener pos. 38.

Completed: [ ]

STEP 3

Apply EMFIMASTIC sealant at skin and its flange, where ribs will be placed, spread it, cleco skin onto ribs. Rivet by 3,2x7,9 blind rivets.

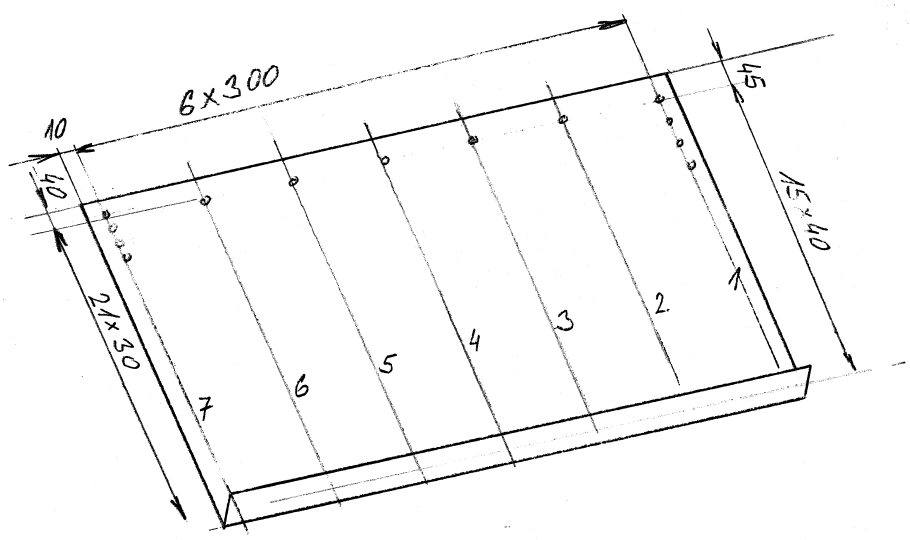
Completed: [ ]

STEP 3A

Riveting of the pitot tube bracket.
According to the drawing E2-00-50 01S (sheet No. 7)fit the semi-circular stiffener pos. 38 in place and drill it together with skin (don't drill holes in the area of the rib No. 9 and the stiffener pos. 39). Rivet the stiffener with the skin. Cut out and clean the hole for the pitot tube bracket. Fit the stiffener pos. 39 in place between ribs No. 8 and 9. Drill and rivet it together with ribs No. 8, 9 and skin.
Mark positions of the riveting nuts pos. 55 on the stiffener and the rib No. 8, and drill and rivet them together. Observe marginal distances of nuts.

Completed: [ ]

STEP 4



Measure lower inner skin, rib No.7 has higher rivets density.
Drill out all holes by 2,5mm diameter drill bit.
Place skin at wing frame to overlap inner and outer skin min. 20 mm and also to see rib flanges central lines through drilled holes. Clamp skin flange to the rivets No. 6, 4 and 1 such to see ribs flange center line through drilled holes in skin. Drill together ribs by three holes, cleco. Use same procedure for ribs No. 5, 3, 2. Finally align rib No. 7. Drill together.
All holes drill by ∅ 2,5 mm drill bit, redrill at 3,3 mm.
Dismount all parts, clean and deburr.

Completed: [ ]

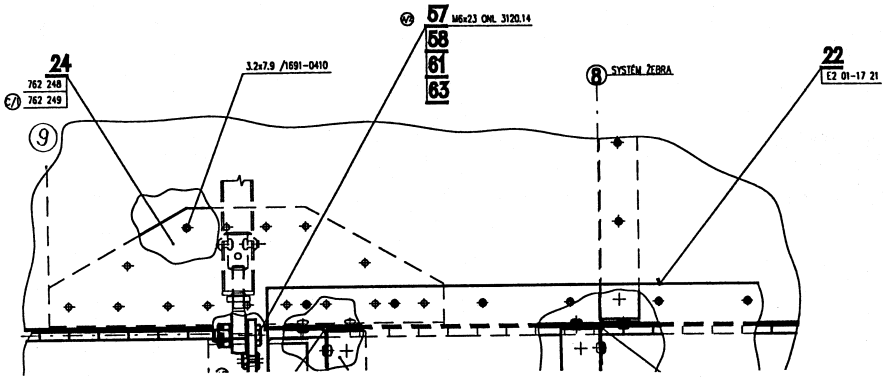
STEP 5

Apply EMFIMASTIC sealant on skin, where rib flanges will contact skin, cleco and rivet step by step.
Place the reinforcement pos. 36 on the lower skin among ribs No. 1 to No. 4 (see photo on the next page.

Trim rib trailing edge if needed (ribs No 1. through No. 4. Drill the reinforcement together with lower skin. Apply EMFIMASTIC sealant at reinforcement and rivet.
Completed: [ ]

STEP 6

Reinforcement pos. 24 riveting.



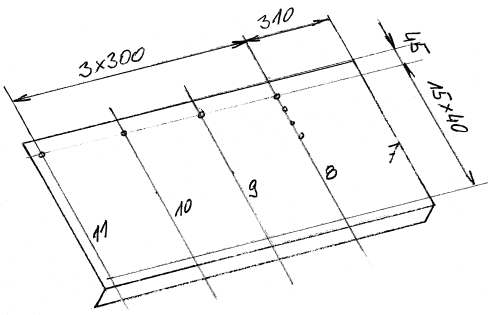
Align reinforcement No. 762 248 to rib 9 and drill together with lower skin. Apply EMFIMASTIC sealant at reinforcement lower side and rivet by 3,2x7,9 rivets.
Completed: [ ]

4. Upper skin riveting

Use same procedure also for lower skin.

STEP 1

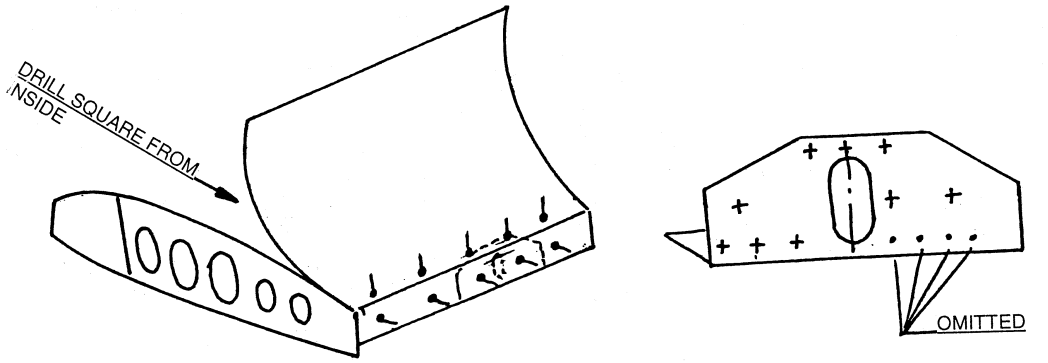
Measure and mark rivet holes for rib No. 8-11 , drill by ∅ 2,5 mm drill bit.



Completed: [ ]

STEP 2

Put skin on frame to skin edge match rib No. 7 and also to see rib flanges central lines through drilled holes. Clamp skin to spar and also to rear rib part No. 7 and 11. Skin flange must be pushed onto rib rear side. Line marking rib flange center must passed under rivet hole centers. If not, align ribs to match it. Cleco rib by three clecos, drill together remained holes by ∅ 2,5 mm, then 3,3 mm. Prior skin removal, remain rear clecos, lift-off skin and drill reinforcement pos. 24 in place of rib No. 9 together with skin rear flange.



Completed: [ ]

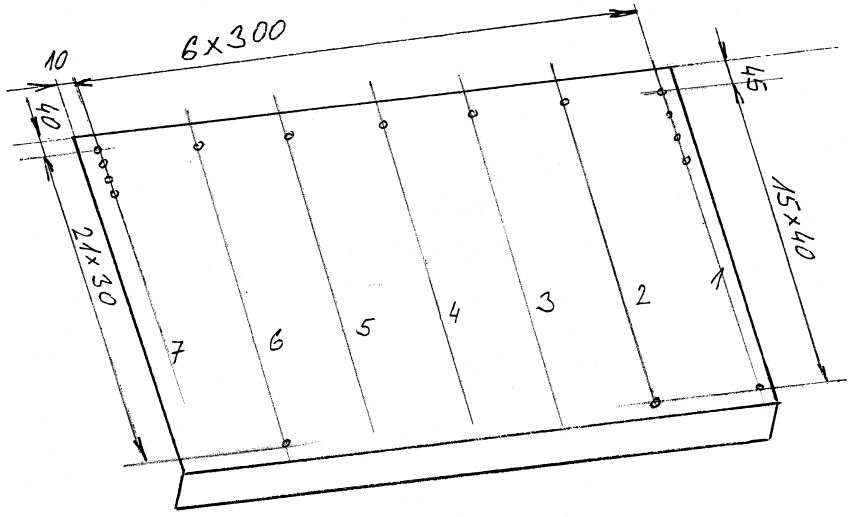
STEP 3

Clean, deburr, apply EMFIMASTIC sealant, cleco skin back, rivet by 3,2x7,9 rivets.

Completed: [ ]

STEP 4

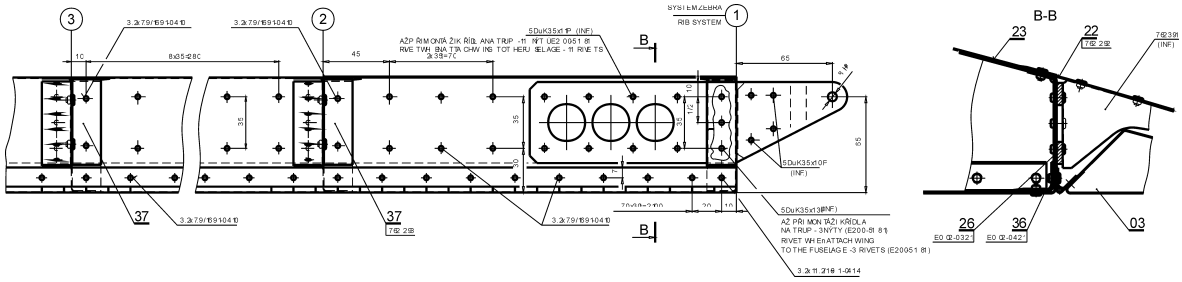
Measure and mark inner skin, drill holes ∅ 2,5 mm where ribs No. 1-7 will be located. Align skin at wing frame, drill holes as mentioned above step by step at ∅ 2,5 mm, cleco, re-drill at ∅ 3,3 mm.



Completed: [ ]

STEP 5

Release and lift off the inner top skin. Place plate E0 02-03 21 pos. 26 and stiffener E0 02-04 21 pos. 36 on rear ribs No. 1, 2 and 3. Mark and drill 18 holes ∅ 2.5 mm on the lower stiffener flange together with lower skin and with the lower rib flange No. 1, 2 3. Join them together by clecos. Put back the top skin and mark all holes (except the holes for rear wing hinge and flap hinge) in the area of plate pos. 26. Drill holes ∅ 2,5 mm, join all parts together by clecos. Re-drill holes at ∅ 3,3 mm.



Completed: [ ]

STEP 6

Reinforcing skin between ribs 1 and 2.

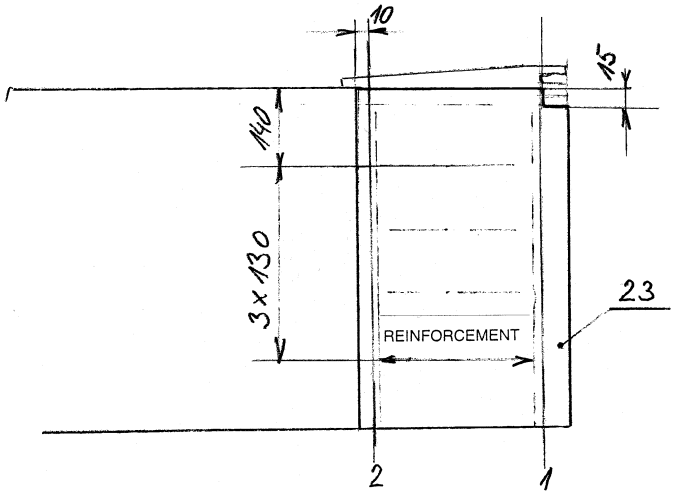


Plate pos. 23 (Pl. 1,2 680x320 mm) align at skin, clamp, drill together with skin, cleco. Align struts between marked ribs flange, drill together with doubled skin. Trim skin overlay pos. 23 around hinge as shown at sketch.

Completed: [ ]

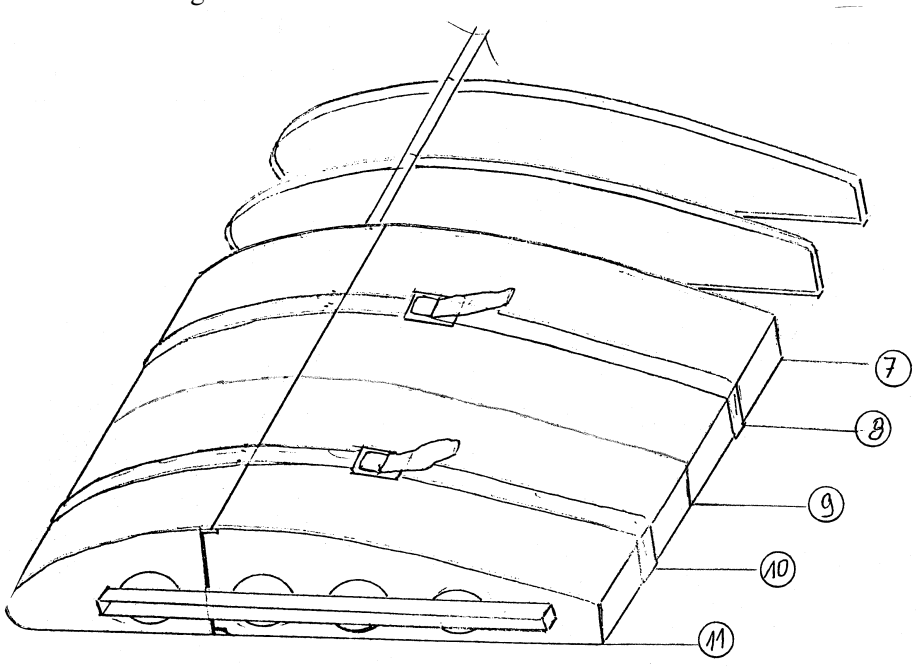
STEP 7

Clean, deburr and apply EMFIMASTIC sealant at all contact surfaces. Apply also sealant at reinforcing skin between ribs No. 1 and 2, except 30 mm strip near by rear hinge.
Cleco and rivet step by step.

Completed: [ ]

5. Leading edge skin riveting

Start with outer skin again.



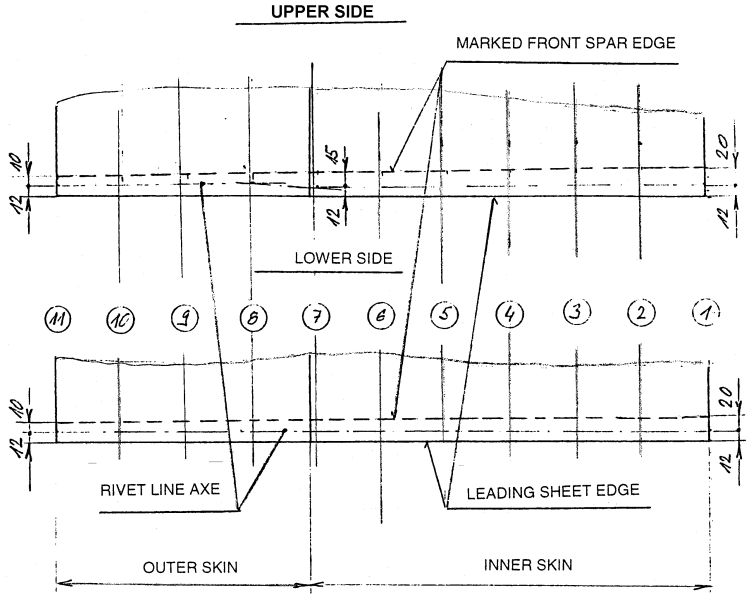
STEP 1

Marking and drilling together.

Align skin to match rib No.7, tighten by rubber straps. It is strongly recommended reinforce tip rib by scantling and clamps. It is to prevent ribs sliding when straps tighten too strong. Mark at both sides of skin the rear half-rib rivet lines. Mark by fine tip marker position of front spar edge at inner skin side. Remove skin and mark carefully spar front edge at both inner sides (upper and lower).

Marked rivet lines connect by flexible strip (shape is curved), mark rivet lines.

Mark rivet line along spar and skin edge conform to sketch.



Trim and deburr sheets edges. Measure rivets spacing. Spacing between ribs 8 and 11 is 40 mm, between ribs 7 and 8 is 30 mm. Rivets spacing at leading edge half-rib is 40 mm, except rib 7 - a 30 mm spacing is applied.

Completed: [ ]

STEP 2

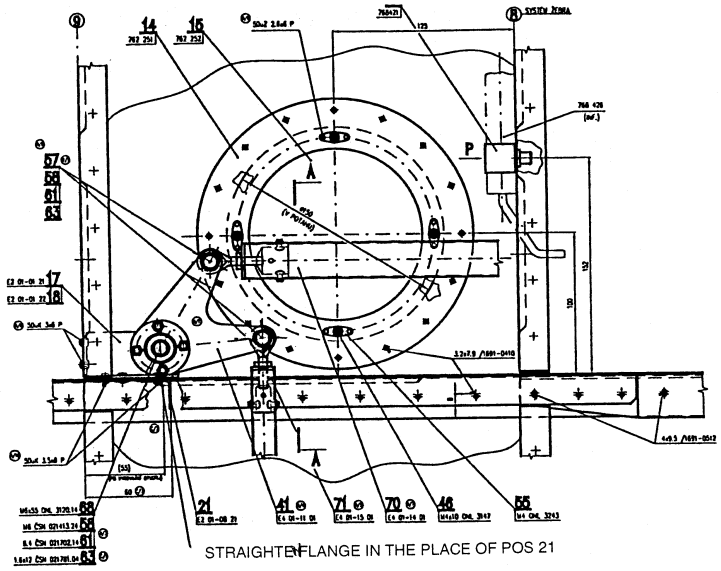
Skin drill.

Drill-out all marked holes by ∅ 2,5 mm drill bit. Set up skin back at wing frame, tighten straps. Check ribs position through riveted holes, align and step by step drill and cleco. Do not drill rib No. 7. Start with holes at spar. Drill-out all holes between clecos, re-drill at ∅ 3,3 mm. Drill holes at spar between ribs No. 7 and 8 at ∅ 4,1 mm. Dismount skin, clear metal chips between spar and rear skin.

Completed: [ ]

STEP 3

Bore or snip-off ∅ 150 mm opening in lower skin between ribs 8 and 9 conform drawing E2 00-50.01, Drill, glue (seal), and rivet frame pos.14 together, including riveting nuts pos. 55. It is recommended perform angle lever pos. 41 assembly prior skin riveting, see sketch.



Completed: [ ]

STEP 4

Skin riveting.

Apply EMFIMASTIC sealant at rib and spar flanges (also between rear skin and spar), align and tight skin by straps, cleco well. Rivet gradually all skin, except rib No.7.

Completed: [ ]

STEP 5

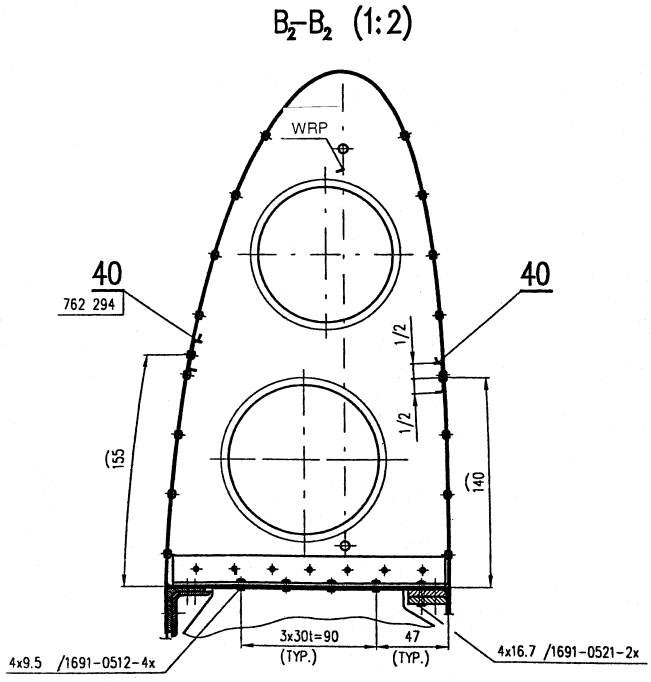
Measuring and marking inner skin perform similar way as above for outer skin (skin closer wing tip).
Trim and deburr skin edges.
Rivets spacing:

Between ribs No.1-4	20 mm
(spacing between ribs No. 1 and No. 2 is for 4th and 5th rivet 25 mm, 5th and 6th rivet 15 mm)	
Between ribs No. 4-7	30 mm
Ribs rivet spacing	40 mm

Completed: [ ]

STEP 6

Drill skin by the same manner as for outer skin (skin closer wing tip). There are used 3,2x7,9 rivets at ribs and 4x9,5 and 4x 12,5 rivets at spar.
Dismount skin, align reinforcements No. 762 297 - pos. 40 between ribs No.1 and 2. Drill and rivet together. Reinforcements location see following sketch.



Completed: [ ]

STEP 7

Perform skin riveting similar as for outer skin.

Completed: [ ]

6. Rear wing hinge riveting

STEP 1

Align hinge at wing conform sketch in section *4. Upper skin riveting, Step 5*.
Hinge offset is 65 mm measured from root rib to hinge axe.
Align vertically hinge at the same level as upper skin.
Mark and drill-out holes ∅ 2,5 mm, cleco hinge, re-drill at ∅ 3,3 except three terminated holes. Clean and deburr hinge, apply EMFIMASTIC sealant, rivet.

Completed: [ ]

7. Flap assembly

STEP 1

Align flap to wing to match aileron and wing lower skin. Mark hinge position at wing. Mark this position at all flap span at wing. Align rivets spacing at flap hinge at 30 mm. Measure terminating rivet holes conform to section *4. upper skin riveting, Step 5*. Drill out ∅ 2,5 mm holes. Do not rivet aileron with wing in this moment.

Completed: [ ]

STEP 2

Reinforcement ribs alignment to flap cover.
Ribs are attached to wing by its own flange and reinforcing profile. Align carefully - terminating ribs have opposite flange than others. First rib does not have reinforcing profile. Mark ribs position at wing auxiliary spar web, align reinforcing profiles, drill together. Drill ∅ 2,5 mm holes into reinforcing profiles in advance. Apply EMFIMASTIC sealant at sealed surfaces, rivet by 3,2x7,9 blind rivets. Modify reinforcing profile length if necessary. This profile can not interfere with flap hinge. Align ribs with upper skin (at one level), clamp with reinforcing profiles, drill together.
Apply sealant at contact surfaces between rib flange and reinforcing profile. Rivet ribs together with reinforcing profiles. Immediately drill and rivet together rib flange with wing auxiliary spar web.

Completed: [ ]

STEP 3

Flap riveting.
Now rivet flap in "up" retracted position. Lower flap and wing skin must match. Check if flap does not interfere with ribs. Modify ribs, when necessary. Rivet together also wing skins where aileron is located during flap hinge riveting.

Completed: [ ]

STEP 4

Flap cover sheet alignment.
Mark by fine tip marker flap ribs flanges center lines at wing skin. Put cover sheet pos. 22 on and insert it under step cover of wing. Sheet must match with flap. A clearance 10 mm must be between flap and aileron, i.e. sheet edge is 170 mm far from rib No. 8. Prolong markings at wing skin at flap cover perpendicularly. Dismount sheet, mark rivet holes center, spacing 40 mm at ribs, 45 mm at wing/sheet connection.

Completed: [ ]

STEP 5

Cover sheet riveting.

Align skin at wing back, drill together with ribs by ∅ 2,5 mm, cleco skin. Finally re-drill holes at ∅ 3,3 mm. Dismount and clean skin, apply EMFIMASTIC sealant at contact surfaces, rivet by 3,2x7,9 blind rivets.

Completed: [ ]

8. Aileron assembly

STEP 1

Aileron alignment.

Measure and mark rivet holes spacing, drill ∅ 2,5 mm holes, align aileron to wing such to have 10 mm gap between aileron and flap and also wing and aileron skins match. Fix aileron hinge by screw driver for instance, put aileron down to open hinge location. Mark hinge location at wing skin. Drill together terminating holes, insert rivets (cleco is too big), check aileron alignment again.

Completed: [ ]

STEP 2

If there is necessary some correction, drill together neighbouring rivet. When proper aligned, drill together all holes in proper position, re-drill at ∅ 3,3 mm, clean and deburr edges, apply sealant and rivet by 3,2x7,9 rivets.

Completed: [ ]

9. Wing tip assembly

STEP 1

If position light will be installed at wing tip pos. 25, pull plus wire through tube to power light. Connect minus wire at tip rib and perform harnesses to power tail position light.

Completed: [ ]

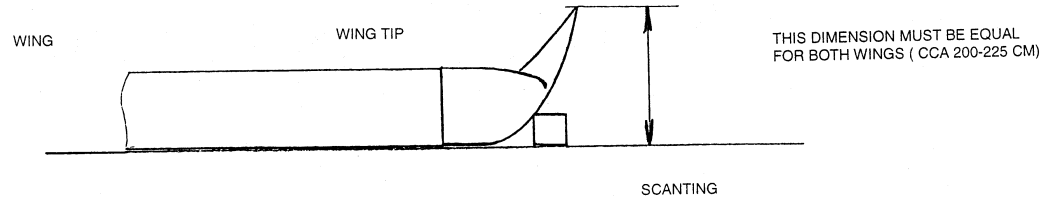
STEP 2

Trim wing tip edge to one plane and snip-off wing skin to match wing tip flange. Wing tip is inserted under skin.

Completed: [ ]

STEP 3

Insert wing tip at wing edge, insert also inserts, thickness 10mm. Support wing tip by scanting. Align wing tip to match wing skin. Press inner wing tip leading edge to wing skin leading edge. Drill out the holes for clecos. Start at leading edge, proceed to trailing edge, cleco during drilling off.



Completed: [ ]

STEP 4

When upper side clecoed, turn the wing and drill and cleco lower side. There is 6 clecos enough to fasten lower side.
Measure and mark remained rivet holes.

Completed: [ ]

STEP 5

Drill-out opening for position light (if installed) when wing tip clecoed.

Completed: [ ]

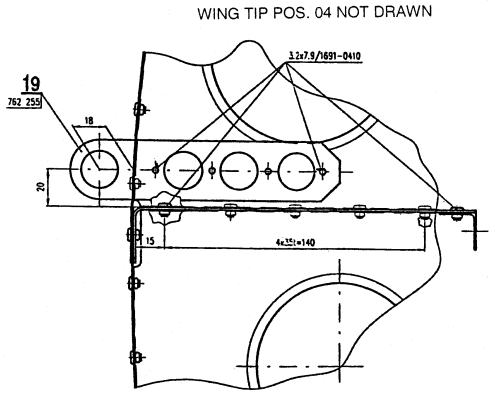
STEP 6

Lift-off aileron and align reinforcement pos. 25 No. 762 265 into wing tip cutout. For better handling drill reinforcement, cleco and keep it at cleco. When aligned, measure, mark and drill-out rivet holes.

Completed: [ ]

STEP 7

Dismount wing tip and reinforcement. Perform openings for anchor brace pos. 19 at the end of wing. Align anchor brace, drill and rivet together. Insert wing tip back at wing, cut-off remained material around anchor brace.



Completed: [ ]

STEP 8

Remove wing tip again, clean and hoover metal chips. Than you can rivet wing tip and reinforcement by blind rivets (apply sealant before).

Completed: [ ]

STEP 9

Check rivets at reinforcement pos. 24 and rivet remained rivets.

Completed: [ ]

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ULTRAKEVYIDEN LENTOKONEIDEN LENTOKELPOISUUS, VALMISTUS, REKISTERÖINTI JA HUOLTO

Tämä ilmailumääräys on annettu ilmailulain (281/95) 5 §:n, 17 §:n ja 21§:n nojalla. Tämä määräys tulee voimaan 1.9.2004 ja kumoaa ilmailumääräyksen AIR M5-10 muutos 2, 25.11.1996. Ilmailumääräyksestä on ilmoitettu Euroopan parlamentin ja neuvoston direktiivin 98/34/EY, muut. 98/48/EY mukaisesti.

1. SOVELTAMINEN

Tätä ilmailumääräystä sovelletaan ultrakevyiden lentokoneiden lentokelpoisuuteen, valmistukseen, rekisteröintiin ja huoltoon.

Ennen tämän määräyksen voimaantuloa aloitettu harrasterakennettavan ultrakevyen lentokoneen rakennustyö voidaan saattaa loppuun noudattaen rakennusluvassa mainittuja ilmailumääräyksiä ja ehtoja.

2. KÄSITTEITÄ JA MÄÄRITELMIÄ

Ultrakevyt lentokone (JAR-1 Definitions ”Microlight” määritelmän mukaan) on enintään kaksipaikkainen kevyt lentokone, jonka sakkausnopeus laskuasussa on enintään 65 km/h (35 knots) CAS ja jonka suurin sallittu lentoonlähtömassa ei ylitä:
- 300 kg yksipaikkaisella maalentokoneella,
- 450 kg kaksipaikkaisella maalentokoneella,
- 330 kg yksipaikkaisella vesilentokoneella tai amfibiolla,
- 495 kg kaksipaikkaisella vesilentokoneella tai amfibiolla.

Ultrakevyellä lentokoneella voidaan toimia sekä maa- että vesilentokoneena, edellyttäen että sen maksimi lentoonlähtömassat ovat molemmissa tapauksissa edellä mainittujen massarajoitusten mukaiset.

Ultrakevyet lentokoneet kuuluvat erityislaatuisina ilma-aluksina koe- ja harrasteluokkaan (experimental). Ultrakevyestä lentokoneesta käytetään jäljempänä lyhennettä UL-lentokone.

UL-lentokoneet jaetaan ohjaustavan perusteella kahteen luokkaan. Luokka A; lentokoneet, joita ohjataan kokonaan tai osittain massakeskiötä siirtämällä ja luokka B; lentokoneet, joita ohjataan ohjainpinnoin. UL-lentokoneen ohjaustapa ilmenee lento-ohjekirjasta.

3. LENTOKELPOISUUS JA MELU

3.1 Lentokelpoisuusvaatimukset

Yleistä

Kaupallisesti rakennettavien UL-lentokoneiden on täytettävä tämän ilmailumääräyksen lentokelpoisuusvaatimusten lisäksi ilmailumääräyksessä AIR M5-1 asetetut lentokelpoisuusvaatimukset sekä ne hyväksymisperusteet, jotka on annettu Lentoturvallisuushallinnon hyväksymässä ultrakevyiden lentokoneiden tarkastuskäsikirjassa.

Harrasterakenteisen UL-lentokoneen on täytettävä tämän ilmailumääräyksen lentokelpoisuusvaatimusten lisäksi ilmailumääräyksessä AIR M5-1 asetetut lentokelpoisuusvaatimukset.

> Huom. "Suomalaisten ultrakevyiden lentokoneiden tarkastuskäsikirja" on Suomen Ilmailuliitto - Finlands Flygförbund ry:n laatima ja Lentoturvallisuushallinnon hyväksymä ohjekirja, joka on laadittu purje- ja moottoripurjelentokoneiden lentokelpoisuusvaatimusten JAR-22 pohjalta.

Lujuus

Rakenteen on kestettävä vähintään seuraavia liikehtimiskuormituskertoimia vastaavat rajakuormat:

a) positiivinen kuormituskerroin 3,8 g ja

b) negatiivinen kuormituskerroin 1,5 g.

Lisäksi rakenteen on kestettävä JAR-22:n mukaisesti määritetyt puuskakuormat. Suunnittelussa on käytettävä JAR-22:n mukaisia varmuuskertoimia. Rakenteen kestävyys vaadittujen rajakuormien alaisena kuormitustapauksissa on näytettävä riittävällä tavalla toteen.

Edellä esitetyt lujuusvaatimukset eivät koske yksipaikkaisia UL-lentokoneita, joiden tyhjämassa on enintään 115 kg. Niiden on kuitenkin kestettävä lennon aikana odotettavissa olevat liikehtimis- ja puuskakuormat niissä olosuhteissa ja tilanteissa, joissa UL-lentokone on suunniteltu käytettäväksi.

Sakkausnopeus

Standardiolosuhteissa sakkausnopeus laskuasussa ilman moottoritehoa (V_{S0}) suurimmalla sallitulla lentoonlähtömassalla ei saa olla suurempi kuin 65 km/h CAS (35 kts CAS). Mikäli UL-lentokoneella ei ole havaittavissa selvää sakkausta, on sakkausnopeus se lentonopeus, millä lentokone on vielä ohjattavissa ja vajoaa 4 m/s (800 ft/min).

Kuormattavuus

UL-lentokoneen kuormattavuuden on oltava vähintään 175 kg kaksipaikkaisilla ja 95 kg yksipaikkaisilla lentokoneilla.

Muut ominaisuudet

B-luokan UL-lentokoneen pääohjainlaitteiden käyttösuuntien on täytettävä JAR-22:n vaatimukset. UL-lentokoneella ei saa olla epätavallisia tai vaarallisia ominaisuuksia tai muita sellaisia ominaisuuksia, joita ohjaaja ei voi hallita ilman poikkeuksellisia taitoja. Tällaisia ominaisuuksia ovat muun muassa hallitsemattoman raju kallistuminen tai hallitsematon syöksykierteeseen joutuminen sakkaustilanteessa.

3.2 Vaatimukset varusteille

Mittarit

UL-lentokoneessa käytettäville lennonvalvonta- ja moottorinvalvontamittareille ei vaadita tyyppihyväksymistä. Mittareiden on oltava kuitenkin aiottuun tarkoitukseen sopivat.

Istuinvyöt ja muut kiinnitysvarusteet

Istuinvöiden ja muiden kiinnitysvarusteiden on oltava samaa rakennetta ja laatua kuin ilma-aluksiin tai moottoriajoneuvoihin hyväksytyt varusteet. Istuinvöiden kaikkien osien on vapauduttava keskuslukosta siten, ettei lentäjän poistuminen ilma-aluksesta esty. Turvavyöt on asennettava ilmailussa yleisesti hyväksytyllä tavalla (asennusohje FAA AC nro. 43.13-2A). Istuinvöiden on oltava 1.1.2005 jälkeen rekisteröitävissä B-luokan ultrakevyissä lentokoneissa vähintään 4-pistetyyppiset.

3.3 Koelennot

Tapaukset, joissa koelento-ohjelma vaaditaan

Lentoturvallisuushallinnon hyväksymä koelento-ohjelma, jonka pituus on vähintään 45 lentotuntia, on lennettävä

a) tyyppitodistuksen saamiseksi UL-lentokonetyypille, jolla ei ole kohdan 3.7 vaatimukset täyttävää ulkomaista tyyppitodistusta ja

b) kaikilla harrasterakenteisilla UL-lentokoneilla.

Lentoturvallisuushallinnon hyväksymä koelento-ohjelma, jonka pituus on vähintään 10 lentotuntia on lennettävä

a) tyyppitodistuksen saamiseksi UL-lentokonetyypille jolla on ilmailuviranomaisen tai sen valtuuttaman organisaation myöntämä tyyppitodistus, jonka perustana olevat lentokelpoisuusvaatimukset vastaavat suomalaisia vaatimuksia

b) vesilentovarustuksen tai vastaavien kohdassa 7.5 mainittujen suurten muutostöiden hyväksymiseksi.

Koelennoilla osoitettavat ominaisuudet

Koelennoilla on osoitettava, että UL-lentokoneen suoritusarvot ja muut ominaisuudet täyttävät tämän määräyksen asettamat vaatimukset.

Koelentokirjanpito

Koelentotuloksista on pidettävä kirjaa siten, että sen perusteella voidaan osoittaa edellisessä kohdassa esitetyt vaatimukset täytetyiksi ja laatia riittävät perustiedot ja rajoitukset lento-ohjekirjaa varten. Mikäli koelennot osoittavat, että suunniteltuja rajoituksia tai suunnitteluperusteita on muutettava, on saatujen koelentotulosten perusteella määriteltävä uudet rajoitukset.

3.4 Lento-ohjekirja

UL-lentokoneelta ei vaadita ilmailuviranomaisen hyväksymää lentokäsikirjaa. Tämän sijaan UL-lentokoneella on oltava ilma-aluskatsastajan tarkastama suomenkielinen lento-ohjekirja, josta käy ilmi UL-lentokoneen turvalliseen käsittelyyn vaadittavat tiedot, kuormausohjeet, toiminta- ja käyttörajoitukset, lentokoneen mahdolliset erityisominaisuudet ja tarkastusohjeet ennen lentoa tehtävää tarkastusta varten. Lento-ohjekirjan tyyppitietojen sekä toiminta- ja käyttörajoitusten on vastattava UL-lentokoneen tyyppitietoja ja koelentokertomusta.

Huom. 1 Lento-ohjekirjaa ei vaadita ohjekirjan laatimiseen liittyvillä koelennoilla.

Huom. 2 Lento-ohjekirja suositellaan laadittavaksi seuraavan jaottelun mukaisesti:

a) yleistiedot koneesta
b) toiminta- ja käyttörajoitukset
c) hätätilanneohjeet
d) normaalitoimintaohjeet ja moottorin käyttöohjeet
e) suoritusarvot
f) kuormausohjeet
g) liitteet.

Huom. 3 UL-lentokoneen lento-ohjekirjan laadinnassa apuna suositellaan käytettäväksi Suomen Ilmailuliitto - Finlands Flygförbund ry:n mallin mukaista lento-ohjekirjaa UL-lentokoneelle.

3.5 Huolto-ohjeet

UL-lentokoneen huoltoa varten on oltava huolto-ohjeet. Ohjeisiin on tehtävä tarpeelliset muutokset

ilma-aluksen käytöstä saatujen kokemusten mukaan ja lentokelpoisuusmääräysten niin edellyttäessä.

3.6 Melu

Enimmäismeluraja

UL-lentokoneen enimmäismeluraja on 68 dB (A) mitattuna ylilennossa 300 metrin (1000 ft) korkeudella suurimmalla jatkuvalla tehoasetuksella.

Melumittaus

Tyyppitodistuksen saamiseksi UL-lentokoneelle on tehtävä melumittaus ilmailumääräyksessä AIR M15-1 esitetyllä tai muulla Lentoturvallisuushallinnon hyväksymällä tavalla. Tietylle UL-lentokonetyypille tehty melumittaus on voimassa kaikille tyyppitietojen mukaan samantyyppisille UL-lentokoneille. Ulkomailla tehdyt kansainvälisen siviili-ilmailun yleissopimuksen liitettä 16 (Annex 16) vastaavat melumittaukset voidaan hyväksyä, mikäli ne on tehty kyseisen maan ilmailuviranomaisen hyväksymällä tavalla.

Harrasterakenteiselle UL-lentokoneelle vaaditaan melumittaus, ellei UL-lentokonetta läheisesti vastaavan muun UL-lentokoneen melumittausta voida pitää riittävän tarkkana myös kyseessä olevalle UL-lentokoneelle. Melumittauksen suorittaa ilma-aluskatsastaja.

Melumittaustodistus

Melumittaustodistuksesta on käytävä ilmi UL-lentokoneen tyyppimerkintä, valmistaja, moottorin tyyppimerkintä, potkurin tyyppimerkintä ja äänenvaimentimen tyyppimerkintä sekä tiedot käytetyistä tehoasetuksista sekä sääolosuhteista, joissa melumittaus on tehty.

3.7 Tyyppitodistus

Tapaukset, joissa tyyppitodistus vaaditaan

UL-lentokonetyypin tyyppitodistus vaaditaan kaupallisesti valmistetuille UL-lentokoneille ja kaupallisesti valmistettuina rakennussarjoina myytäville UL-lentokoneille, jos rakennussarjan valmistaja tai myyjä tai he yhdessä ovat tehneet rakennustyöstä 50 % tai enemmän.

Harrasterakennetulta UL-lentokoneelta ei vaadita tyyppitodistusta.

Hakemus

Maahantuojan tai valmistajan on haettava tyyppitodistusta Lentoturvallisuushallinnosta kirjallisesti viimeistään kahta viikkoa ennen ensikatsastusta (tarkastuksessa noudatetaan ilmailumääräystä AIR M1-11 soveltuvin osin). Hakemuksesta on käytävä ilmi UL-lentokoneen valmistaja, valmistajan tyyppimerkintä, valmistusmaa ja tiedot maahantuojasta. Hakemukseen on liitettävä seuraavat asiakirjat:

a) valmistusmaan ilmailuviranomaisen myöntämä tyyppitodistus tai vastaava, mikäli tällaista todistusta aiotaan käyttää hyväksi tarkastuksessa

b) selvitys siitä, miten UL-lentokone täyttää Suomessa voimassaolevat erityisvaatimukset

c) luettelo suunnittelun perustana olevista lentokelpoisuusvaatimuksista

d) valmistajan laatima lento-ohjekirja liitteineen sekä kohdassa 3.4 tarkoitettu suomenkielinen lento-ohjekirja

e) valmistajan laatimat huolto-ohjeet

f) valmistajan laatimat huoltotiedotteet

g) moottorin valmistajan laatimat moottorin käyttö- ja huolto-ohjeet

h) valmistusmaan ilmailuviranomaisen julkaisemat, kyseistä tyyppiä koskevat lentokelpoisuusmääräykset

i) yhteenveto lujuuslaskelmista ja -kokeista

j) yhteenveto hyväksymiseen liittyvistä koelennoista

k) melumittaustodistus

Tarkastus ja tyyppitodistuksen myöntäminen

UL-lentokonetyyppi katsastetaan tarkastuksen yhteydessä. Lentoturvallisuushallinto myöntää UL-lentokoneelle tyyppitodistuksen, jos tarkastuksessa todetaan, että
- kohdissa 3.1 - 3.6 annetut vaatimukset täyttyvät ja jos
- tarvittavat asiakirjat sekä Suomen Ilmailuliitto ry:n lausunto ja tyyppitarkastusraportti on toimitettu Lentoturvallisuushallinnolle.

Lentoturvallisuushallinto myöntää tyyppitodistuksen toisessa yhteisön jäsenvaltiossa laillisesti valmistetuille tai markkinoiduille tai Euroopan talousalueesta tehdyn sopimuksen allekirjoittaneessa EFTA-valtiossa valmistetuille, tai toisessa yhteisön jäsenvaltiossa tai Euroopan talousalueesta tehdyn sopimuksen allekirjoittaneessa EFTA-valtiossa laillisesti rekisteröidyille ultrakevyille lentokonetyypeille, mikäli ultrakevyt lentokonetyyppi täyttää kohdan 2. mukaisen määritelmän, seuraavilla perusteilla:

a) toisen yhteisön jäsenvaltion tai Euroopan talousalueesta tehdyn sopimuksen allekirjoittaneen EFTA-valtion ilmailuviranomaisen myöntämän tyyppitodistuksen perusteella, ellei lentoturvallisuusviranomainen syystä katso, että kyseinen ultrakevyt lentokonetyyppi ei tarjoa samanlaista todellisen julkisen edun mukaista suojelun tasoa kuin sellainen ultrakevyt lento-

konetyyppi, joka on 3.1-3.6 kohdassa tarkoitettujen kansallisten eritelmien mukainen, tai

b) toisen yhteisön jäsenvaltion tai Euroopan talousalueesta tehdyn sopimuksen allekirjoittaneen EFTA-valtion ilmailuviranomaisen, hakijan toimittamien asiakirjojen tutkimuksen jälkeen, suorittaman tarkastuksen tulosten perusteella, ellei lentoturvallisuusviranomainen syystä katso, että kyseinen ultrakevyt lentokonetyyppi ei tarjoa samanlaista todellisen julkisen edun mukaista suojelun tasoa kuin sellainen ultrakevyt lentokonetyyppi, joka on 3.1-3.6 kohdassa tarkoitettujen kansallisten eritelmien mukainen.

Lentoturvallisuushallinto pitää luetteloa Suomessa hyväksytyistä UL-lentokonetyypeistä.

4. VALMISTUS

4.1 Kaupallinen valmistus

UL-lentokoneita, rakennussarjoja tai niiden osia saa Suomessa valmistaa tai koota kaupallisesti ainoastaan Lentoturvallisuushallinnon myöntämällä luvalla.

4.2 Harrastevalmistus

UL-lentokoneen harrasterakentamisessa on voimassa, mitä ilmailumääräyksessä AIR M5-2 harrasterakenteisten ilma-alusten rakentamisesta määrätään.

5. REKISTERÖINTI, LUPA ILMAILUUN JA RAJOITETTU LENTOKELPOISUUSTODISTUS

5.1 Rekisteröinti ja ilma-aluksen merkitseminen

Rekisteröintimenettely

UL-lentokone on rekisteröitävä ja merkittävä kansallisuus- ja rekisteritunnuksin. UL-lentokoneen rekisteröinnissä noudatetaan ilmailulain ja -asetuksen säännöksiä sekä ilmailumääräystä AIR M1-1.

Kansallisuus- ja rekisteritunnus

UL-lentokoneen kansallisuus- ja rekisteritunnusten osalta noudatetaan ilmailulain säännöksiä sekä ilmailumääräystä AIR M1-2 allamainituin poikkeuksin.

a) Kansallisuustunnuksen muodostavat kirjaimet OH. Rekisteritunnuksen muodostavat U-kirjain ja kolme tai neljä numeroa.

b) Jos UL-lentokoneen muoto tai rakenne on sellainen, ettei ilmailumääräyksen AIR M1-2 mukaisten tunnusten sijoittaminen runkoon tai siipeen ole mahdollista, voi katsastaja hyväksyä kooltaan kyseisestä määräyksestä poikkeavat tunnukset. Tunnusten luettavuus ei saa kuitenkaan olennaisesti huonontua.

Merkinnät ja kilvet

- UL-lentokoneessa on oltava ohjaajan ja matkustajan nähtävissä seuraavan sisältöinen kilpi.

VAROITUS
Tämä on tyyppihyväksymätön ultrakevyt lentokone

- UL-lentokoneen ohjaamon läheisyyteen ulkopuolelle on merkittävä vähintään 30 millimetriä korkeilla kirjaimilla teksti "EXPERIMENTAL".
- UL-lentokoneessa on oltava ohjaajan ja matkustajan nähtävissä kuormausrajoituskilpi, josta on käytävä ilmi vähintään seuraavat tiedot:
  1. Suurin sallittu lentoonlähtömassa
  2. Punnituksessa todettu perusmassa
  3. Suurin sallittu matkatavaran massa
  4. Taulukko suurimmista sallituista ohjaamokuormista 25%, 50% 75% ja 100% polttoainekuormilla. Jos UL-lentokoneessa on matkatavaratila on matkatavaroiden vaikutus huomioitava 0%, 50% ja 100% matkatavaramassoilla. Mikäli massakeskiön asema rajoittaa ohjaamokuormia tai edellyttää tasapainoitusmassojen käyttämistä on sen käytävä ilmi kuormausrajoituskilvestä.

  Kuormausrajoituskilpi on asennettava seuraavan punnituksen yhteydessä, kuitenkin viimeistään 30.4.2005.
- Huom. UL-lentokoneen kuormaustaulukon laadinnassa apuna suositellaan käytettäväksi Suomen Ilmailuliitto - Finlands Flygförbund ry:n ohjetta kuormaustaulukon laadinnasta.

5.2 Lupa ilmailuun ja rajoitettu lentokelpoisuustodistus

Lupa ilmailuun

Lupa ilmailuun UL-lentokoneella voidaan myöntää ilmailumääräyksen AIR M1-3 mukaisesti. Harrasterakenteisesta UL-lentokoneesta vaaditaan ilmailumääräyksen AIR M5-2 mukaiset selvitykset ja asiakirjat.

Rajoitettu lentokelpoisuustodistus

UL-lentokoneelle voidaan myöntää rajoitettu lentokelpoisuustodistus ilmailumääräyksen AIR M1-3 mukaisesti. Rajoitettu lentokelpoisuustodistus voidaan myöntää katsastuksen jälkeen edellyttäen, että

a) UL-lentokone täyttää tässä määräyksessä asetetut vaatimukset ja että

b) lentokone on tyyppitodistuksen ja lento-ohjekirjan tyyppitietojen mukainen. Harrasterakentei-

sesta UL-lentokoneesta vaaditaan ilmailumääräyksen AIR M5-2 mukaiset selvitykset ja asiakirjat.

Mikäli lentokonetta muutetaan ilman kohdan 7.5 mukaista menettelyä siten, ettei se vastaa tyyppitodistuksen tai lento-ohjekirjan tyyppitietoja, raukeaa rajoitetun lentokelpoisuustodistuksen voimassaolo.

6. KATSASTUS

Määräykset ja ohjeet katsastustoiminnan järjestelystä on julkaistu ilmailumääräyksessä AIR M16-1 ja ilmailutiedotuksessa AIR T16-4, joista poiketen UL-lentokoneille sovelletaan seuraavia vaatimuksia ensikatsastuksessa esitettävien asiakirjojen osalta:

Lentokelpoisuusasiakirjat:

- Harrasterakenteisia UL-lentokoneita koskevat vaatimukset on esitetty ilmailumääräyksen AIR M5-2 kohdassa 11.
- Tyyppitodistuksen omaavia UL-lentokoneita koskevat seuraavat vaatimukset:

    1. ilmailuviranomaisen tai sen valtuuttaman organisaation myöntämä, voimassaoleva rajoitettu lentokelpoisuustodistus tai vastaava
    2. ultrakevyen lentokoneen rakentamiseen liittyvät mittaus-, punnitus- ja koelentopöytäkirjat
    3. matkapäiväkirja tai muut tarvittavat selvitykset koneen käyttötuntimääristä
    4. vastuuvakuutustodistuksen jäljennös
    5. radiolupa, jos radio on asennettu
    6. suomalainen punnituspöytäkirja ja –todistus
    7. suomalaisen lento-ohjekirjan yksilöintisivun kopio

Kopiot näistä asiakirjoista sekä suomalainen katsastuspöytäkirja rajoitettua lentokelpoisuustodistusta varten on lähetettävä Lentoturvallisuushallinnolle rajoitetun lentokelpoisuustodistuksen myöntämistä varten.

Ultrakevyellä lentokoneella on lisäksi oltava:

1. suomenkielinen lento-ohjekirja liitteineen
2. ultrakevyen lentokoneen huolto-ohjekirja, lisäksi moottorin, potkurin ja muiden varusteiden ohjekirjat, jos tarvittavia tietoja ei ole huolto-ohjeissa (ohjeet voivat olla englanninkieliset)
3. matkapäiväkirja
4. moottorikirja
5. laitekortit aikavalvottaville laitteille

7. HUOLTOTOIMINTA

7.1 Yleistä

UL-lentokoneen huoltotoiminnassa on noudatettava tämän määräyksen lisäksi ilmailumääräystä AIR M1-5, jollei kohdissa 7.2 - 7.8 ole annettu tästä poikkeavia määräyksiä.

7.2 Määräaikaishuollot, vuositarkastus ja pienet korjaukset

UL-lentokoneelle on tehtävä huolto-ohjeiden edellyttämät huollot sekä vuositarkastus. Vuositarkastus on tehtävä ilmailumääräyksen AIR M1-5 mukaisesti. Määräaikaishuollot, vuositarkastukset ja pienet korjaukset saa tehdä huoltomekaanikon lupakirjan haltija, UL-lentokoneen omistaja, haltija tai käyttäjä.

> Huom. Jos valmistaja ei ole laatinut huolto-ohjeita, voidaan määräaikaishuollon ja vuositarkastuksen ohjeina käyttää Suomen Ilmailuliitto - Finlands Flygförbund ry:n laatimia UL-lentokoneen huolto-ohjeita.

7.3 Suuret korjaukset ja peruskorjaukset

UL-lentokoneen peruskorjaus. Rakenteen ja järjestelmien korjaus.

UL-lentokoneen peruskorjauksen tai kantavien rakenteiden tai ohjainjärjestelmien korjauksia saa tehdä huoltomekaanikon lupakirjan haltija, ilmailuvälinehuolto-organisaatio, UL-lentokoneen valmistaja tai muu organisaatio Lentoturvallisuushallinnon erillisellä luvalla. Harrasterakenteisen UL-lentokoneen korjaustyöt saa tehdä myös rakennusluvassa mainittu organisaatio.

Peruskorjauksen ja lentokelpoisuuteen vaikuttavan vaurion korjauksen jälkeen UL-lentokone on katsastettava ennen lentotoiminnan jatkamista.

Moottorin korjaus ja peruskorjaus

Moottorin suuren korjauksen ja peruskorjauksen saa tehdä huoltomekaanikon lupakirjan haltija, hyväksytty huolto-organisaatio, UL-lentokoneen rakennusluvassa mainittu organisaatio tai muu organisaatio Lentoturvallisuushallinnon erillisellä luvalla. Huoltotyön tekijällä on oltava siihen riittävät edellytykset ja toimenpiteet on tehtävä valmistajan ohjeita noudattaen.

7.4 Korkeusmittarin tarkastus

Korkeusmittarille on tehtävä ilmailumääräyksen AIR M11-7 mukainen aneroidikoe enintään viiden vuoden välein. Korkeusmittarin virhe ei saa ylittää kyseisen määräyksen mukaisia toleransseja.

7.5 Muutostyöt

Suuret muutostyöt

UL-lentokoneeseen tehtävälle sellaiselle muutostyölle, jonka tekeminen saattaa vaikuttaa olennaisesti ilma-aluksen ominaisuuksiin, erityisesti lujuuteen, suoritusarvoihin, massaan, massakeskiöasemaan, lento-ominaisuuksiin tai muihin lentokelpoisuuteen vaikuttaviin ominaisuuksiin tai meluun, on haettava Lentoturvallisuushallinnon hyväksyminen sekä lupa työn tekemiseen. UL-lentokone on lisäksi katsastettava ennen lentotoiminnan jatkamista.

> Huom. Muutostyö voi edellyttää kohtien 3.1 - 3.7 mukaisten tarkastusten ja kokeiden tekemistä uudelleen muutetulla lentokoneella tai uusien asiakirjojen laadintaa, esimerkiksi lento-ohjekirjan tai huolto-ohjeiden muuttamista.

Pienet muutostyöt

Muut muutostyöt kuin edellisessä tarkoitetut työt saa tehdä huoltomekaanikon lupakirjan haltija, hyväksytty huolto-organisaatio, UL-lentokoneen omistaja, haltija tai käyttäjä.

7.6 Lentokelpoisuusmääräykset

Omistajan, haltijan tai käyttäjän on huolehdittava siitä, että UL-lentokoneeseen tehdään ne lentokelpoisuusmääräysten mukaiset toimenpiteet, kuten tarkastukset ja muutostyöt, jotka ovat välttämättömiä kaluston jatkuvalle lentokelpoisuudelle ja jotka Lentoturvallisuushallinto määrää tehtäväksi.

7.7 Punnitus, massantarkkailu ja kuormausrajoitukset

Yleistä

UL-lentokoneen punnituksessa on noudatettava UL-lentokoneen valmistajan antamia ohjeita, niiden ollessa vajavaisia noudatetaan soveltuvin osin ilmailumääräystä AIR M6-2 "Purjelentokoneiden ja moottoripurjelentokoneiden punnitus ja massantarkkailu". Punnitsijalla on oltava Lentoturvallisuushallinnon myöntämä punnituskelpuutus, huoltomekaanikon lupakirja, lentokoneenrakennuksen diplomi-insinöörin tutkinto tai huolto-organisaation toimilupa, joka kattaa ilma-alusten punnitukset.

Punnitus

Punnitus on tehtävä:

1. Suomalaisen rajoitetun lentokelpoisuustodistuksen myöntämistä varten, ellei UL-lentokoneella ole konekohtaista punnitustodistusta, josta luotettavasti selviää koneen massa ja massakeskiön sijainti sekä koneen varustus punnittaessa. Ko. punnitustodistus ei saa olla viittä vuotta vanhempi.
2. Sellaisten suurehkojen korjausten ja muutostöiden jälkeen, joiden vaikutus massaan ja massakeskiön sijaintiin ei ole tarkasti laskettavissa, kuitenkin vähintään joka viides vuosi.
3. Milloin Lentoturvallisuushallinto katsoo punnituksen tarpeelliseksi.

Punnituksesta on tehtävä punnituspöytäkirja ja -todistus sekä näiden perusteella on laadittava kuormausrajoituskilpi, asiakirjat on vahvistettava punnitsijan nimikirjoituksella ja punnituspäivämäärällä. Punnituspöytäkirja ja -todistus on sijoitettava lento-ohjekirjan liitteeksi ja kuormausrajoituskilpi on asennettava ilma-aluksen ohjaamoon. Kopiot asiakirjoista on toimitettava lentoturvallisuushallintoon kahden viikon sisällä punnituksesta.

Massantarkkailu

Jos UL-lentokoneen varustuksessa suoritetaan muutoksia tai korjauksia, joiden yhteisestä vaikutuksesta perusmassa muuttuu enemmän kuin ± 3 kg tai massakeskiö siirtyy enemmän kuin ± 1 cm, on vastaavat muutokset tehtävä viimeisen punnitustodistuksen kohtaan "Punnituksen jälkeen suoritetut muutokset".

7.8 Tekninen kirjanpito

Kaikki huoltotyöt, muutostyöt mukaan lukien on merkittävä UL-lentokoneen matkapäiväkirjaan.

8. POIKKEUKSET MÄÄRÄYKSEN VAATIMUKSISTA

Lentoturvallisuushallinto voi hakemuksesta myöntää UL-lentokoneille poikkeuksia tämän määräyksen vaatimuksista, jos se katsoo, että poikkeukset ovat tarpeellisia ja että määräyksen tarkoitusta vastaava turvallisuustaso saavutetaan hakijan esittämillä keinoilla.

Aamulehti 10.02.2005, Tänään, sivu 22
Jenita Sillanpää

Pikkukoneeseen ei lyödä virheniittejä

Tulevat lentokoneinsinöörit nakuttavat tuhansia tunteja pienkonetta kokoon

Antti Ojasen, Jari Nymanin ja Kristian Ansaharjun suut ovat korvissa asti, kun he purkavat muoveista kaksipaikkaisen lentokoneen runkoa. Tunnelma on kuin pikkulapsilla jouluaattona, kun muovit avautuvat tsekkiläisen **Eurostar** EV-97 -koneen rungon yltä. Paketista paljastuu alumiininen kehikko, joka näyttää amatöörin silmissä lentokoneen vartalolta, mutta ei paljon muuta.

- On tämä hienoa, aivan kuin olisi joulu taas, nuoret miehet hymyilevät tohkeissaan.

Ojasella, Nymanilla, Ansaharjulla ja reilulla kolmellakymmenellä muulla Tampereen ammattikorkeakoulun lentokonetekniikan opiskelijalla alkaa muovien purkamisen jälkeen rankka projekti.

Eurostarin pitäisi lentää neitsytlentonsa ennen juhannusta - ja sitä ennen koneen kokoamiseen kuuluu vähintään 1 000-2 000 tuntia vapaa-aikaa.

- Tuntiarvio on tehtaan tekemä, mutta meillä tähän menee varmasti kauemmin noin 2 000-4 000 tuntia, projektivastaava Ansaharju neljänneltä vuosikurssilta kertoo.

Pienlentokoneen kokoamisprojekti on ainutlaatuinen tempaus. Se, että koneen osat ovat viimein luokan pöydillä Tampereella matkattuaan monta päivää Tsekistä, on jo huikea saavutus. On tarvittu lukemattomia tunteja suunnittelua, kokoamisoppia ja rahankeruuta. Ilmaiseksi konetta ei saatu, vaan yritykset ja yksityishenkilöt ovat lahjoittaneet TAMK:n lentokonekerhon projektiin tarvittavat 40 000 euroa.

*- **Lentävät laitteet lähellä sydäntä** -*

Opiskelijat tienaavat lentokoneen kokoamisesta opintoviikkoja ja elintärkeää kokemusta.

- Kaikki lentävät laitteet ovat lähellä sydäntäni, joten olen enemmän kuin innoissani. Myös mahdolliset tulevat työnantajat pitävät tällaista tilaisuutta hyvänä oppimisprosessina, Nyman hehkuttaa.

Lentokonetekniikan laboratoriomestari Jukka Vanne vakuuttaa, että alan suurimmat kotimaiset työnantajat, kuten Patria Aviation, Finnair ja Ilmavoimat ovat olleet kovin kiinnostuneita projektista. Opiskelijaryhmä pääsi ennen omaa projektiaan harjoittelemaan koneen osien niittaamista Patrian tehtaalla. Alumiinilevyjen niittaaminen onkin eräs koneen kokoamisen tärkeimmistä työvaiheista.

- Yhtään virheniittausta ei koneeseen saa tulla, koska alumiinilevyä ei voi jälkikäteen korjata, osastonjohtaja Heikki Aalto kertoo.

Kaikkein eniten aikaa vie siipien rakentaminen.

- Niittaamiseen menee paljon aikaa, sillä ensin porataan reikä, sitten poistetaan purseet, liimataan ja sitten vasta niitataan. Oikea niittauskohta saattaa olla milleistä kiinni, joten aikaa menee oikean kohdan löytämiseenkin, Vanne kertoo.

*- **Se lentää sittenkin** -*

Oppilaat on jaettu 6 ryhmään, joilla on yhteensä 18 työtehtävää. Tehtäviin kuuluu niittauksen lisäksi muun muassa avioniikka eli koneiden elektroniikka ja työn tarkastus. Ojanen ja Nyman ovat niittausryhmässä. Vaikka molemmat valmistuvat tänä keväänä, he aikovat olla mukana projektin loppuun saakka.

- Lentoonlähtö on nähtävä. Jokainen on sitoutunut hommiin niin vakavasti, ettei kukaan halua jättää tätä kesken, nuoret miehet lupaavat.

Eurostar EV-97 on ultrakevyt pienlentokone. Vastaavia koneita on harrastuskäytössä paljon ympäri Suomen. Samanlaisella koneella myös Tampereen ammattikorkeakoulun rehtori Markku Lahtinen on tottunut lentämään. Kesän neitsytlennolle on tarjolla lentäjäksi monta lentolupakirjallista TAMK:n ilmailukerholaista, mutta jos rehtori astuisi puikkoihin ensimmäisenä, olisi ensimmäinen lento täydellinen.

- Luotan opiskelijoihin täysin, joten en pelkäisi lentää koneella ensimmäisenä. Katsotaan nyt, kuinka kova kisa ensimmäisen lentäjän paikasta kehkeytyy, rehtori tokaisee.

Kuva: Ja paketista paljastuu...
Kristian Ansaharju (vas.), Jari Nyman ja Antti Ojanen purkavat muoveista TAMK:n kauan odotettua ihmettä: tsekkiläistä ultrakevyttä lentokonetta.
Linjanjohtaja Heikki Aalto sanoo lentokoneen kokoamisen olevan suurempi projekti kuin omakotitalon rakentaminen.

AAMULEHTI

Viikko 26 N:o 175 (39894) 124. vuosikerta ■ Keskiviikko 29. kesäkuuta 2005

Näillä siivillä noustaan vielä ilmaan

Elina Laurila

Alussa oli palapeli, jossa oli tuhansia osia. Nyt on osittain koottu pienkoneen runko ja puolivalmiit siivet.

Tampereen ammattikorkeakoulun lentokonetekniikan opiskelijoiden unelma päässee neitsytlennolle ensi syksynä. Pienkoneen kokoamisurakka alkoi viime helmikuussa.

– Koko ajan motivaatio kasvaa, kiteyttää opiskelija Pauli Rompasaari koneenkokoajien ajatukset.

Tänään, B 20

Ilkka Laitinen – Aamulehti

Tarkkaa työtä. Jari Vuorenmaa, Juha Antila ja Kristian Ansaharju poraavat niiteille reikiä.

Pienkoneen neitsytlento taas niitin verran lähempänä

Elina Laurila
Ilkka Laitinen, kuvat

Tulevien lentokone-insinöörien pienkone muistuttaa jo lentokonetta

Tampereen ammattikorkeakoulun pihassa on hiljaista. Kaikki ovet ovat lukossa. Missään ei näy ristinsielua.

Toisen kerroksen luokkahuoneessa sen sijaan on elämää. Kesälomalle ei ole kiire, kun telineessä odottaa puoliksi koottu lentokoneen siipi. Osittain koottu koneen runko makaa paria kerrosta alempana toisessa luokkahuoneessa.

Tampereen ammattikorkeakoulun lentokonetekniikan opiskelijat aloittivat viime helmikuussa ainutlaatuisen urakan. He ryhtyivät kokoamaan kaksipaikkaista ultrakevyttä lentokonetta.

– Nyt olemme yhden päivän myöhässä aikataulusta, **Jari Vuorenmaa** hymyilee ja viittaa juhannukseksi kaavailtuun neitsytlentoon.

Näillä näkymin kone kantaa ensimmäistä matkustajaansa ennen ensi talven lumia.

– Kun mikään ei prässää, niin halutaan tehdä kunnolla. Ei sillä aikataululla ole niin väliä, osastonjohtaja **Heikki Aalto** kuittaa.

Ei lomaa. Jari Vuorenmaa (vas.), Pauli Rompasaari, Juha Antila, Aki Penttinen, Kristian Ansaharju ja Jonne Uusitupa urakoivat koko kesän koneenrakennuksen parissa.

Viisaat päät yhteen

Kovimmille joutuvat kokoajien nupit, sillä välillä pohditaan porukalla pää sauhuten, mikä olisi paras mahdollinen ratkaisu missäkin tilanteessa. Periaatteena on koko urakan ajan ollut se, että aina kysytään ja mietitään yhdessä, kun jokin asia vähänkin askarruttaa.

Toisinaan opiskelijoiden ideat ovat ajaneet tehtaan ohjeiden ohi. Ja mikä tärkeintä, vakavilta virheiltä on toistaiseksi vältytty.

– Minä ihailen tätä porukkaa, osaamista on ollut, Aalto kiittelee.

Projektivastaava **Kristian Ansaharju** neljänneltä vuosikurssilta kaivaa esiin laskusiivekkeiden ohjeen. Ohje on nivaska paperia, jossa on ensin valokuva jokaisesta osasta, osalista, lista tarvittavista työkaluista ja ohje asennusvaiheista.

– Haaste on siinä, että aina ohje ja piirustukset eivät mene yhteen, Ansaharju kertoo.

Silloin taas mietitään.

Tunteja ei lasketa

Aluksi lentokone oli melkoinen palapeli. Osien tarkkaa lukumäärää ei ole laskettu, mutta Aalto arvelee niitä olevan tuhansia. Ansaharju lisää, että osien kiinnittämiseen käytettäviä niittejä on noin 3 500.

Keväällä konetta on ollut kokoamassa kaikkiaan noin 40 opiskelijaa. Nyt kesällä koneen parissa puurtaa kuuden opiskelijan joukko. Lentotekniikan laboratoriomestari **Jukka Vanne** arvelee, että ainakin 4 000 työtuntia tulee täyteen ennen kuin kone on valmis. Kokoajia työn määrä ei haittaa, vaikka osalla on kasassa jo 400 työtuntia koneen kimpussa.

– Kyllä tässä motivaatio kasvaa koko ajan, **Pauli Rompasaari** kiteyttää ja muut nyökkäilevät.

– Mitä nopeammin koneen saa valmiiksi sitä nopeammin unelma täyttyy. On se hienoa nähdä oman käden jälki, Vuorenmaa kuvailee.

Ei mikään ihme, että aikaa kuluu, sillä kaikki tehdään viimeisen päälle huolellisesti. Myös tehtaan kiinnittämät niitit käydään yksitellen läpi – eikä turhaan.

– Nämä täytyy irrottaa ja laittaa uudet. Kanta irvistää, Vuorenmaa osoittaa muutamaa niittiä koneen rungossa.

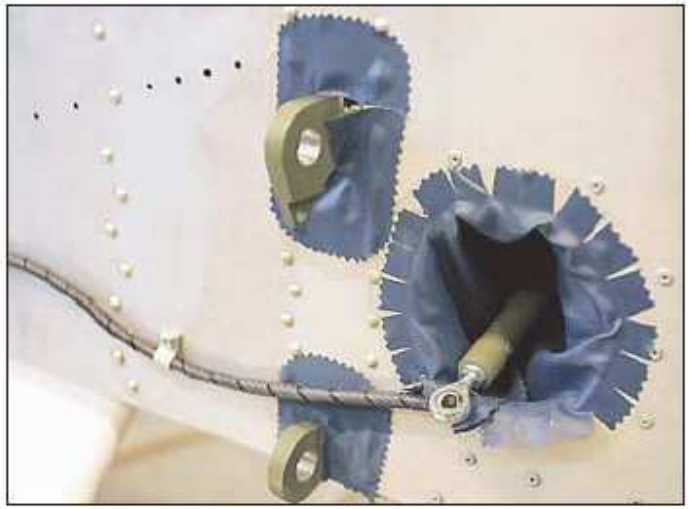
Kun tehdään nuukaa työtä, yksikään kanta ei saa irvistää. Yhtään heikkoa lenkkiä koneeseen ei haluta.

Ensimmäisen koelennon pääsee tekemään ammattikorkeakoulun rehtori **Markku Lahtinen**. Kaikkiaan koelentoja tehdään kymmenkunta.

Tätä kootaan

Sata heppaa. Moottori on jo asetettu paikalleen.

- Kone on tsekkiläinen kaksipaikkainen ultrakevyt Eurostar EV-97 -kone. Moottori on satahevosvoimainen Rotax.
- Kone painaa ilman polttoainetta ja matkustajia 275 kiloa. Ultrakevyt kone saa painaa polttoaineineen ja matkustajineen korkeintaan 450 kiloa.
- Polttoainesäiliöön mahtuu 55 litraa polttoainetta. Hyvissä olosuhteissa koneella voi lentää kerrallaan viisi tuntia.
- Koneen maksiminopeus on 170 kilometriä tunnissa, lentokorkeus parhaimmillaan useita tuhansia metrejä.



Näillä pysyy. Tähän kiinnitetään aikanaan koneen siipi.

Ohjaamo. Penkit ja ohjaussauvat ovat jo paikallaan.

Uusiksi. Tehtaan tekemä työ ei kelpaa tarkan työn tekijöille.

Penkin taakse. Bensatankki odottaa vielä ikkunalla.

TAMK:n lentokoneprojekti loppusuoralla

Tampereen ammattikorkeakoulu on saamassa päätökseen Suomessa ensimmäistä kertaa toteutettavan projektin, jossa oppilaat rakentavat osatoimitetun lentokoneen alusta loppuun.

Koneen jokaisen osa-alueen rakentaminen vaatii omaa erikoisosaamista. Siksi projekti on erinomainen oppilaiden ja oppimisen kannalta ajateltuna.

Tampereen ammattikorkeakoulu on ainoa ammattikorkeakoulu Suomessa, jossa suuntautumisvaihtoehtona on Lentokonetekniikan linja. Nyt linjalla opiskelevat oppilaat ovat saaneet ainutlaatuisen mahdollisuuden toteuttaa oppejaan myös käytännössä. Viime vuoden aikana pohjustettu oma lentokoneprojekti näki päivänvalonsa 4.2.2005, jolloin koneen ensimmäiset osat saapuivat Suomeen.

Tuhannen palan palapeli

Viime joulukuussa tilattu tšekkiläinen kone on tyyppiä Eurostar EV-97. Projekti aloitettiin 39 oppilaan voimin, joka jaettiin ryhmiin. Kullekin ryhmälle annettiin omat vastuualueensa. Vastuualueiden jakaminen olikin peruteltua, sillä lentokone toimitettiin osatoimituksena, joka käsitti 1.000 nimikettä. Toukokuun lopussa tekijäjoukko tiivistettiin seitsemään oppilaaseen, jotka tekivät projektia täyspäiväisesti koko kesän. – Kesän aikana työ eteni aivan toisella vauhdilla, kun pystyimme keskittymään projektiin täyspäiväisesti eikä tarvinnut keskittyä muihin oppiaineisiin, kertoo projektissa tarkastajana aloittanut Jari Vuorenmaa. Vuorenmaalla onkin vankka kokemus koneenrakentamisesta ennen nykyisiä opintoja, sillä hän on työskennellyt 11 vuotta Patrialla.

Ilmaan vielä tänä vuonna

Projekti alkaa olemaan kesän uurastusten jälkeen loppusuoralla. – Edessä on vielä viimeisten osien asennus sekä viimeistelytyöt. Tämän jälkeen on vuorossa ilmailulaitoksen tarkastus, jonka jälkeen kone nousee aikataulun mukaisesti ilmaan vielä tämän vuoden

Tiimityön merkitys on ollut oleellinen Eurostar EV-97 -projektissa.

aikana, kertoo Lentokonetekniikan osastolla työskentelevä laboratoriomestari Jukka Vanne.

Nyt toteutettu projekti saanee jatkoa lähitulevaisuudessa. Lentokonetekniikan linjanjohtaja Heikki Aalto kertoo projektin palvelevan erinomaisesti opintoja. Myös opiskelijat kehuivat vuolaasti projektin antia. – Tämä oli ensimmäinen kerta kun tämän mallinen kone rakennettiin Suomessa ja ensimmäinen kerta laatuaan opiskelijatyönä toteutettuna. Projekti on saanut kaikilta osapuolilta niin positiivisen palautteen, että Tampereen ammattikorkeakoulussa tullaan jatkossakin toteuttamaan vastaavia projekteja, päättää Heikki Aalto.

Ydinjoukko projektin takana. Pauli Rompasaari (vas.), laboratoriomestari Jukka Vanne, Lentokonetekniikan linjanjohtaja Heikki Aalto, Juha Antila, Aki Penttinen, Jari Vuorenmaa ja Janne Uusitupa.

Eurostar EV-97 pähkinänkuoressa:

Rakennusmateriaalit	Alumiini, hiilikuitu, lasikuitu
Kärkiväli	7,90 m
Pituus	5,98 m
Siipipinta-ala	9,48 m²
Laskutelineen malli	Nokkapyörälaskuteline
Liitosuhde	1:10
Sakkausnopeus laskussa	65 km/h
Tyhjäpaino	272 kg
Maksimi lentomassa	450 kg
Matkanopeus	160 – 200 km/h
Kohoamisnopeus max painoin	min. 5 m/s
Toimintamatka	600 - 700 km
Moottori	Rotax 912 ULS 73,5 kW (100 hv)
Polttoaineet	95E, 98E ja 100LL

Kevytilmailukone koulutyönä

TAMK:n ILMAILUKERHON EUROSTAR-PROJEKTI

Tampereen ammattikorkeakoulun päärakennuksen alakerrassa sijaitseva vanha valimo on saanut mielenkiintoista uusiokäyttöä. Vaikka tilassa ei enää metallivalun saloja opiskellakaan, sovelletaan siellä edelleen teoriatunneilla opittua käytäntöön. Nyt vain kohde on vaihtunut: Lähinnä Kone- ja tuotantotekniikan osaston lentokonetekniikan suuntautumisvaihtoehdon opiskelijoista koostuva TAMK:n Ilmailukerho rakentaa huoneessa Evektor EV-97 Eurostar -ultrakevyttä, jonka yhdistys hankki keräysvaroin viime syksynä.

Eurostar-projektin tarkoituksena on käytännön taitojen lisäksi myös erään unelman toteuttaminen: monet mukana olevista haluaisivat jonain päivänä lentää lupakirjakurssin yhteisvoimin rakennetulla koneella. Siivet-lehti ryhtyy nyt seuraamaan kerholaisten taivalta, joka alkaa koneen rakentamisesta ja toivottavasti päättyy ultrakevytkurssin järjestämiseen.

Kun lennokki ei riitä

– Tämän siitä saa, kun lukee pienenä liikaa Korkeajännitystä ja rakentaa lennokkeja, sanoo siivekkeen saranan kiinnitysreikiä poraava Antti Ojanen.

Ojanen kuuluu yhdessä Ilpo Vuorisen, Kristian Ansaharjun, Jari Nymanin ja Niko Hyvärisen kanssa viisihenkiseen niittausryhmään, jonka vastuulla on Eurostarin oikean siiven kokoaminen ja päällystäminen alumiinilevyllä sekä muihin niittaustöihin osallistuminen. Ryhmästä huokuu aito pikkupoikamainen innostus ilmailuun. Osalla ovat opinnot jo takanaan ja insinöörin paperit taskussa. Silti askeleet suuntautuvat projektihuoneelle ilta illan jälkeen, eikä tunteja lasketa.

– Tänne sitä vain tullaan raskaan päivän jälkeen vaikka silmät sirrillään, nauraa Jari Nyman.

TAMK:n ilmailukerhon Eurostar-hanke sai alkunsa viime vuonna. Alun perin kerholaisten aikomuksena oli tehdä komposiittirakenteinen lentävä malli Myrsky-hävittäjästä mittakaavassa 1:8. Pian kuitenkin päädyttiin täysikokoisen ultrakevyen rakentamiseen. Kerho päätti tilata Trade Aid Oy:ltä Eurostarin rakennussarjan, jonka hankkiminen rahoitettiin pirkanmaalaisilta yrityksiltä ja yksityisiltä saaduin lahjoituksin.

Hankintapäätöksen synnyttyä kerho teki viime syksynä ekskursion Tshekkiin Evektorin tehtaalle tutustuakseen valmistajan tapaan rakentaa koneensa. Tehdasvierailun perusteella koneen kuomu ja korkeusvakaaja päätettiin tilata valmiiksi rakennettuina.

Muilta osin TAMK:n ilmailukerhon Eurostar tehdään Basic Kitistä, jossa on äärimmäisen vähän tehtaalla koottuja komponentteja. Tammikuussa Tampereelle saapuikin rekan kyydissä osittain kootun rungon lisäksi liuta irto-osia sisältäviä pahvilaatikoita, ja rakennustyö alkoi kirjaimellisesti alkutekijöistä.

Suoran pöydän rakennussarja

Alkuun väistämättä kuuluvien kangertelujen jälkeen työ on lähtenyt hyvin käyntiin. Huhtikuun puolivälissä koneen siipien rakenne ja siivekkeet olivat jo miltei valmiit, ja toukokuun aikana siivet on määrä päällys-

Teksti: Ville Tuokko
Kuvat: Ville Tuokko ja TAMK:n ilmailukerhon arkisto

Eurostarin nokalla ei ole vielä muuta kuin nokkateline kumilenkkijousituksineen. Koneen tulevaksi voimanlähteeksi on kuitenkin jo valittu 100-hevosvoimainen Rotax 912S.

Eurostaria siirretään sisätiloihin. Innolla odotettu rekkalasti saapui Tampereen ammattikorkeakoululle tammikuussa 2005.

Projektityöhuoneeksi nimetty TAMK:n vanha valimo muodostaa hyvät puitteet lentokoneen rakentamiselle.

Koneen ohjaamon osalta työt ovat vielä alkuvaiheessa. TAMK:n ilmailukerho asentaa koneeseensa aluksi vain perusavioniikan. Myöhemmin varustusta on kuitenkin tarkoitus täydentää.

tää. Myös nokkateline on saatu paikoilleen.

Niittiryhmä luonnehtii konetta melko helpoksi rakentaa. Eurostar on suunniteltu suoralla pöydällä koottavaksi, eikä työläitä jigejä ole tarvinnut rakentaa kuin reikien poraamista varten.

Eniten kritiikkiä saavat osakseen rakennusohjeet, jotka ovat osittain ristiriitaisia ja puutteellisia.

– Ainakin sen olemme oppineet, että jos olet työvaiheessa kolme, niin kannattaa silti lukea etukäteen myös se, mitä työvaiheessa yksitoista neuvotaan tekemään, Jari Nyman kuvailee.

Joitakin ratkaisuja, joihin ohjeet eivät ole antaneet osviittaa, onkin tehty täysin itse. Täysin niittiryhmän omaa käsialaa on muun muassa siivekeohjauksen työntötankojen saranoiden kiinnitys.

Niin kuin harrasterakennusprojekteissa usein käy, ei TAMK:n ilmailukerhonkaan hanke ole sujunut aivan suunnitelmien mukaan. Eurostar oli alun perin määrä varustaa heti aluksi parhaalla mahdollisella avioniikalla. Ajatuksesta kuitenkin luovuttiin, ja nyt kone lentänee ensilentonsa minimivarustuksella. Asialla on kuitenkin hyväkin puolensa: koneen avioniikan parantaminen muodostaa aikanaan oivallisen harjoitusprojektin nuorempien vuosikurssien opiskelijoille.

Tieteellisen tarkkaa työnohjausta

Osaltaan projektin nopeaa sujumista on auttanut hyvä organisointi. Osa kerholaisista liittää Eurostarin rakentamisen osaksi tuotantotalouden ja projektityön opintojaan tai päättötyötään, mikä takaa hankkeen insinööritieteellisen tarkan järjestämisen. 39 hengen vahvuinen rakennusporukka on jaettu Eurostarin rakennusmanuaalin lukujaon perusteella erilaisiin työryhmiin: kahden siipien niittausryhmän lisäksi konetta rakentavat muun muassa moottoriryhmä, runkoryhmä ja avioniikkaryhmä.

Työnjakoa on myös pyritty suunnittelemaan niin, että jokainen pääsee opiskelemaan uusia asioita. Lukiotaustan omaavat opiskelijat on laitettu harjaannuttamaan käytännön lentokoneenrakennustaitoja, kun taas toisen asteen lentokoneasentajakoulutuksen saaneet perehtyvät enemmän lasku- ja suunnittelutaitoja vaativiin tehtäviin.

Myös tuntiseuranta, joka on ollut tarkempaa kuin yleensä ultrien rakentamisessa, kertoo osaltaan projektin hyvästä etenemistahdista:

– Keskimäärin aktiivirakentajat ovat työskennelleet 60–120 tuntia ja kaiken kaikkiaan konetta on rakennettu 600–700 tuntia. Valmistajan arvion mukaan sarjan tekemiseen kuluu tuhannesta kahteentuhanteen tuntia, mutta käytännössä ehkä kaksinkertainen aika, Kristian Ansaharju kertoo.

Tampereen ammattikorkeakoulun henkilökunta tukee opiskelijoiden hanketta ja seuraa mielenkiinnolla sen etenemistä. Rakennustyön virallisena valvojana toimii lentokonetekniikan suuntautumisvaihtoehdon linjanjohtaja Heikki Aalto. Myös itsekin Eurostarilla lentävä TAMK:n rehtori Markku Lahtinen on lentokoneverstaalla usein nähty vieras.

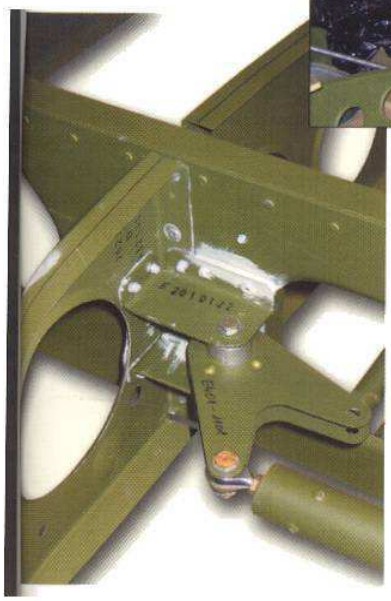
Koska Eurostarin sitten valmistuu, ja unelma TAMK:n ilmailukerhon omasta lupakirjakurssista voi toteutua?

– Kyllä se juhannuksena lentää, joku niittiryhmäläisistä heittää.

– Vielä ei vaan tiedetä, minä vuonna, jatkaa toinen.

Jäämme seuraamaan, kuinka käy. Vakavammin harkittujen arvioiden mukaan odotettu hetki voisi koittaa kesällä 2006. ✈

Niittiryhmä työssään. Jari Nyman poraa siivekkeen saranan kiinnitysreikiä ja Antti Ojanen varmistaa.



Joskus pienten yksityiskohtien toteuttamiseen kuluu paljon aikaa ja vaivaa. Siivekeohjauksen työntötankojen saranoiden kiinnitys jouduttiin rakentamaan itse.

EUROSTAR- PROJEKTI, OSA II

Teksti ja kuvat:
Ville Tuokko

PELLITYS ALKOI, PEHMUSTEET KASTUIVAT

Tampereen ammattikorkeakoulun ilmailukerhon Eurostar-hanke on edennyt siipipeltien niittaukseen saakka. Jotta työlle saataisiin enemmän tilaa, on siivet siirretty koulun vanhasta valimosta kerrosta ylempänä sijaitsevaan projektihuoneeseen.

Toukokuun alusta lähtien siipien parissa on työskennellyt täyspäiväisesti kuusihenkinen tiimi, joka on työn edistymisen myötä päässyt hyvään vauhtiin:

- Vasemman siiven alapinnan pellittämiseen meni kaksi viikkoa ja oikean vain kolme päivää, Kristian Ansaharju kertoo.

Eniten aikaa siipien niittauksessa ovat vieneet valmistelut, ei itse niittaustyö. Vasemman siiven osalta työtä vaikeutti myös pitotputken asennus, jota varten täytyi porata reiät ja suunnitella oikeat tukien paikat.

Siipien päällystykseen on saatu ohjeita alan ammattilaisilta. Patria Aviationin lentokoneenrakentajat neuvoivat Hallissa käyneitä kerholaisia muun muassa niittauksessa.

- Saimme Patrialta ohjeen, että siipi kannattaa laittaa jigiin ylösalaisin, jotta sen voi porata ja niitata paikoillaan. Evektorin ohje oli, että siiven pitäisi olla toisinpäin, kertoo Jari Vuorenmaa.

Ero ohjeissa johtuu Evektorin työtavasta, jossa niittien pellistä ulos tulevat osat uppoavat työalustana olevaan pehmeään vanerilevyyn. Kovalla pöydällä tätä tapaa ei voi käyttää.

Siipien niittauksen ohessa ovat kerholaiset ehtineet tehdä muutakin: Eurostarin korkeusperäsin on kiinnitetty alustavasti paikoilleen ja sivuperäsintä kootaan parhaillaan. Myös laskusiivekkeiden käyttökahva ja trimmivipu ovat paikoillaan. Seuraavaksi on tarkoitus sovittaa pyrstön osat lopullisesti paikoilleen ja asentaa ohjausvaijerit.

Juha Antila ja Jari Vuorenmaa niittaushommissa.

Myös Rotax 912 -moottorin asennuksen aika koittaa kohta. Mallia ja vinkkejä työhön käytiin hakemassa Malmilta, jossa Kari Aspiola suoritti moottorinvaihdon erääseen Eurostariin. Tuleviin työvaiheisiin kuuluu myös kojetaulun mittarireikien poraaminen. Se tehdään, kun Eurostarin mittarit ovat saapuneet.

Myös pieni takaisku mahtuu hyvin edenneeseen projektiin: Ohjaamon verhoilujen piti olla valmiit ja paikallaan tätä juttua varten otetuissa kuvissa. Verhoilijan pajassa sattunut vesivahinko kuitenkin kasteli materiaalit ja lykkäsi Eurostarin penkkien valmistumista. +

EUROSTAR- PROJEKTI, OSA III

NIITINKITTAAJIA ODOTELLESSA

Teksti ja kuvat:
Ville Tuokko

Kesätyökiireet verottivat TAMK:n ilmailukerhon Eurostar-projektin tekijätiimiä kesäkuukausina. Heinäkuun lopulla konetta rakensi vain viiden sitkeän insinööriopiskelijan ryhmä. Myös syksyllä kouluun palaavalle loppuporukallekin oli jo töitä katsottuna:

– Siinä on meille ne, jotka täyttävät niitinreiät, hymähtää ryhmää luotsaava Jari Vuorenmaa.

Kitattavia niittejä onkin kesän aikana lyöty paikoilleen melkoinen liuta: Eurostarin siipien ylä- ja alapinnat on nyt pellitetty kokonaan. Myös opettajaporras on tyytyväinen suojattiensa kädenjälkeen.

– Poikien työn jälki on hyvää. He tekevät helppotekoisia ja toimivia ratkaisuja, arvioi lentokonetekniikan suuntautumisvaihdon linjanjohtaja Heikki Aalto.

Kuten niin monta kertaa aikaisemminkin, siipien yläpinnan kokoonpanossa törmättiin ongelmiin, jotka johtuvat koneen valmistajan Evektorin laatiman dokumentoinnin virheistä. Oikean siiven takakorvakkeen paikkaa pohtiessaan kerholaiset huomasivat, että työohjeen kuva ja korvakeasennuksen piirustus poikkesivat toisistaan. Evektorin mukaan piirustuksen ohje oli oikea, joten sitä noudatettiin myös asennuksessa.

Piirustuksen mukaisessa asennuksessa korvakkeen yläreuna olisi kuitenkin asettunut siiven yläpinnan peltiä korkeammalle. Ongelma ratkesi välilevyllä, joka nostaa siipipellin korkeammalle korvakkeen kohdalta. Muiden rakennustöissä ilmenneiden ongelmien tavoin kerholaiset tekivät myös tästä pulmasta ja sen ratkaisusta tarkat muistiinpanot.

– Olemme dokumentoineet kaikki ongelmat. Jos joku vielä rakentaa Suomessa Eurostaria, meiltä kannattaa kysyä neuvoa, Vuorenmaa vihjaa.

Seuraava siipien rakennuksen työvaihe on lasku- ja ohjaussiivekkeiden sekä laippojen päälle ulottuvan siiven yläpinnan levyn kiinnittäminen. Ohjaussiivekkeen kiinnittämisen tekee haasteelliseksi lasikuituinen siivenkärki, joka on asennettava paikoilleen samaan aikaan siivekkeen saranoinnin kanssa.

Rungonkin rakentaminen on edistynyt, vaikka rakentajaviisikko on keskittynyt kesän aikana lähinnä siipien kokoonpanoon. Kastuneet ohjaamon verhoilut on kuivattu ja asennettu paikoilleen, ja Eurostarin Rotax 912 -moottori on kiinnitetty pukkiinsa. Myös moottorin apulaitteiden sijoittelu on aloitettu.

Myös Eurostarin laskutelineet pyörineen on asennettu alustavasti paikoilleen. Niiden kiinnityspultteja ei kuitenkaan ole vielä väännetty momenttiin, sillä runko siirretään pian pois Tampereen Ammattikorkeakoulun vanhasta konepajasta. Sen uusi osoite on koulun autolaboratorio, jossa koneen siivet on tarkoitus liittää kiinni runkoon.

– Tavoitteena on saada kone esittelykuntoon autolabraan parin viikon sisällä. Sitten on jäljellä vielä kuukausien työ, kuvailee Jari Vuorenmaa projektin aikataulua. +

Rakentajaviisikko pohtii Rotax-moottorin apulaitteiden asettelua. Kuvassa vasemmalta Aki Penttinen, Pauli Rompasaari, Juha Antila, Jari Vuorenmaa ja Jonne Uusitupa.